**Neuropsychological dysfunctions among chronic schizophrenia patients, alcohol dependence cases, and normal subjects: A comparative study**

**A B S T R A C T**

**Aim:** The aim of this study is to assess the neuropsychological profiles of chronic schizophrenia and alcohol-dependent subjects. **Materials and Methods:** This hospital-based cross-sectional study included 30 chronic schizophrenia patients, 30 alcohol-dependent patients and 30-matched normal controls. Demographic and clinical data were collected on a self-designed pro forma. Positive and Negative Syndrome Scale (PANSS) and Severity of Alcohol Dependence Questionnaire (SADQ-C) were administered to chronic schizophrenia and alcohol-dependent patients, respectively. The AllIMS Comprehensive Neuropsychological Battery in Hindi (Adult Form) was used to assess neuropsychological dysfunctions. **Results:** Neuropsychological dysfunctions were found in 83.3% of chronic schizophrenia patients, 36.7% alcohol dependents and none of the normal subjects. In comparison to normal subjects, schizophrenia patients had significantly more dysfunctions in neuropsychological-domains such as motor, tactile, visual, receptive and expressive speech, reading, writing, arithmetic, memory, and intellectual processes. A significant positive correlation was found between the PANSS total score and T scores of most of the clinical scales except motor and visual scales; the PANSS general psychopathology score and T scores of most of the clinical scales except visual scale; and the PANSS positive score and T scores of receptive speech, arithmetic, and memory scales. In comparison to normal subjects, the alcohol dependents had significantly more dysfunctions in neuropsychological-domains such as motor, tactile, visual, receptive and expressive speech, reading, writing, arithmetic, and memory. A significant positive correlation was found between the SADQ total scale and T scores of clinical scales such as expressive speech, writing, arithmetic, intellectual processes, left hemisphere, and total battery scales. **Conclusions:** Neuropsychological dysfunction was significantly more common and severe in chronic schizophrenia patients than in alcohol-dependent patients. In comparison to alcohol dependents, the chronic schizophrenia patients had more dysfunctions in neuropsychological-domains such as tactile, arithmetic, memory, and intellectual processes.

**Keywords:** Alcohol dependence, psychopathology, reading, schizophrenia, speech, writing

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Neuropsychology is the study of brain-behavior relationships and involves assessment of memory, abstract reasoning, problem-solving, spatial abilities, and the emotional and personality consequences of brain dysfunction. Neuropsychological assessment ideally provides a clear, coherent description of the impact that brain dysfunction. Neuropsychological assessment ideally provides a clear, coherent description of the impact that brain dysfunction has on cognitive function. This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

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dysfunction has had on a person’s cognitions, personality, emotions, interpersonal relationships, vocational functioning, educational potential, and ability to enjoy life. Schizophrenia is fundamentally a neurobiological disorder, that is usually accompanied by neurocognitive deficits. Patients with schizophrenia perform one to two standard deviations below healthy controls on various neurocognitive tests. The profile of deficits is broad, severe, and is present in almost all patients. On the basis of various cluster analytic studies, several general cognitive subtypes of schizophrenia have been identified. Cluster analytic studies have identified four clusters that usually contain one neuropsychologically normal cluster and one severely and broadly impaired cluster. The other two clusters vary in their profiles but are usually impaired (with differing degrees of severity), and show one or two areas of neuropsychological impairment (e.g., motor, verbal memory, or executive functioning). The severity of this impairment is the greatest in the domains of memory, attention, working memory, problem-solving, processing speed, and social cognition.

Severe chronic use of alcohol is associated with neuropsychological impairments with respect to cognitive flexibility, problem-solving, decision-making, risky behavior and so on. As a group, the alcohol-dependent patients without symptoms of persisting amnesic syndrome or dementia, in comparison to groups of controls, generally demonstrate moderate impairments of several cognitive domains: predominantly deficits in executive functioning, deficits in verbal and nonverbal abstraction, in memory and perceptual-motor behavior.

Neuropsychological impairment in schizophrenia remains relatively stable over time, whereas recovery of cognitive functions has been observed in alcohol dependents who maintain prolonged abstinence of alcohol. However, even with abstinence, not all cognitive functions show recovery or recover to levels equal to those of the controls. A comprehensive assessment of neuropsychological functioning is necessary because neuropsychological deficits are mentioned to have an impact on rehabilitation and overall treatment outcome in both schizophrenia and chronic alcoholism.

Earlier studies on neuropsychological functioning in schizophrenia patients and chronic alcoholics have compared schizophrenia patients with Alcoholic Korsakoff Syndrome patients, with non-Korsakoff alcoholics, and some with no clear mention of composition of the alcoholic group. In most of these studies, there were control groups comprising normal healthy individuals who performed better than both schizophrenia patients and alcohol dependents. However, a comparative comprehensive neuropsychological profile of schizophrenia and chronic alcoholism was not performed.

Neurocognitive tests often assess more than one domain of functioning, and many tests do not fit neatly into a single domain. Thus, the profile of neuropsychological deficits in schizophrenia and chronic alcoholism has varied. A comprehensive assessment of the neuropsychological status of schizophrenia patients on Luria Nebraska Neuropsychological battery (LNNB), one of the most widely reported standardized research tool in research on neuropsychological functioning, has been done in both India and abroad. Similarly, LNNB has also been used to assess neuropsychological functioning in chronic alcoholics. The AIIMS Comprehensive Neuropsychological Battery (AIIMS CNB) is another fixed approach neuropsychological battery. Its availability in Hindi makes it more suitable to administer on the Indian population. However, even after a decade of its development, there are no studies that utilize the battery to assess neuropsychological dysfunctions in psychiatric patients. In view of the above, the present study was conducted to assess and compare neuropsychological dysfunctions of chronic schizophrenia patients, alcohol-dependent patients, and normal controls with the help of the AIIMS CNB.

MATERIALS AND METHODS

This hospital-based cross-sectional study was conducted at Ranchi Institute of Neuro-Psychiatry and Allied Sciences (RINPAS), Kanke, Ranchi (India). It is a premier postgraduate training and research institute of psychiatry, clinical psychology, psychiatric social work, and psychiatric nursing. It is a tertiary referral center for psychiatric patients. Approval of the Institutional Ethical Committee was obtained before starting the study. All the patients gave written informed consent.

Sample
By purposive sampling technique, 30 chronic schizophrenia patients, 30 alcohol dependents, and 30 normal subjects, fulfilling the exclusion and inclusion criteria, were enrolled in the study from the inpatient department of RINPAS. The normal control subjects, who fulfilled the inclusion and exclusion criteria, were selected from the local community, i.e., Kanke and neighboring areas.

Inclusion criteria of chronic schizophrenia patients
- Diagnosed cases of schizophrenia, according to ICD-10DCR.
- At least 2 years of the duration of illness
- Male patients in the age range of 25–50 years
- With primary education, who could read or write
- Patients who were cooperative.
Exclusion criteria of chronic schizophrenia patients
- Comorbid psychiatric disorder
- Vision and hearing impairment
- History suggestive of organic pathology, substance abuse (except tobacco), mental retardation, or significant physical illness
- History of electroconvulsive therapy (ECT) 6 months before testing.

Inclusion criteria for alcohol dependence patients
- Diagnosed cases of alcohol dependence according to ICD10 DCR.[33]
- Taking alcohol for >2 years
- In alcohol abstinence period of at least 2 weeks
- Male patients in the age range of 25–50 years
- With primary education, who can read or write
- Patients who were cooperative.

Exclusion criteria for alcohol dependence patients
- Taking other substances of abuse (except tobacco)
- Comorbid psychiatric disorder including alcohol-induced persistent amnestic syndrome and alcohol-induced dementia
- Vision and hearing impairment
- History suggestive of organic pathology, mental retardation, or significant physical illness
- History of ECT 6 months before testing.

Inclusion criteria for normal subjects
- Normal persons from the general population matched in age, sex, and educational status with chronic schizophrenia patients and alcohol dependents.
- Persons who gave consent to participate in the study
- Persons who scored below a cutoff of 3 on the General Health Questionnaire-12 (GHQ-12).[36]

Exclusion criteria for normal subjects
- Vision and hearing impairment
- History of any psychiatric disorder and significant physical illness
- Substance abuse except tobacco.

Tools for assessment
Socio-demographic and clinical data sheet: This self-prepared pro forma contained questions about demographic variables such as age, sex, religion, education, marital status, occupation, as well as clinical details such as diagnosis, age of onset, total duration of illness, mode of onset, history of alcohol or substance abuse, family history of mental illness, any history of significant head injury, seizures, mental retardation, and any other significant physical, organic or psychiatric illness, medications and their side effects, etc.

Positive and Negative Syndrome Scale (PANSS):[37] To evaluate positive, negative, and other symptom dimensions of chronic schizophrenia patients.

Severity of Alcohol Dependence Questionnaire (SADQ-C):[38] To assess the severity of alcohol dependence in alcohol dependents.

General Health Questionnaire-12 (GHQ-12):[36] To assess psychological well-being of normal subjects.

AIIMS Comprehensive Neuropsychological Battery in Hindi (Adult Form) [34] (AIIMS CNB) was used to create a profile of neuropsychological functioning in chronic schizophrenia patients, alcohol dependents, and normal subjects. This is a reliable and valid instrument to assess neuropsychological dysfunctions and is applicable in both psychiatric and neurological patients.

Procedure
A total of 30 chronic schizophrenia patients, 30 alcohol dependents, and 30 normal subjects, who fulfilled the exclusion and inclusion criteria, were enrolled in the study after obtaining written informed consent. Sociodemographic and clinical data were collected on a self-designed pro forma. PANSS was administered to chronic schizophrenia patients. A description of typological assessment was made in view of Crow’s classification of schizophrenia into two types: type-1 schizophrenia characterized predominantly of negative symptoms and more cognitive impairments, and type-2 schizophrenia predominantly of positive symptoms and less cognitive impairments. Typological assessment is based on two systems, namely the inclusionary system and exclusionary system. In the inclusionary system, the positive or negative value of the composite score (i.e., total positive scale score—total negative scale score) decides the type of schizophrenia to be either positive or negative. The more stringent exclusionary system demands schizophrenia to be called “positive type” if the scores of three or more items of the positive scale are of moderate or above severity level, along with scores of <2 items of the negative scale to be of moderate or above severity level; “negative type” if scores of three or more items of the negative scale are of moderate or above severity level, along with scores of <3 items of the positive scale to be of moderate or above severity level; “mixed type” if scores of three or more items of both positive and negative scales are of moderate or above severity level; and “neither type” if scores of <3 items of both positive and negative scales are of moderate or above severity level. SADQ-C was administered to alcohol dependents who were abstinent of alcohol for at least 2 weeks and were not showing any withdrawal features to assess the severity of alcohol dependence.
The AIIMS CNB was administered individually to each subject of the three groups using the standardized administration procedure. Assessments were performed in a fixed order in a quiet room. With the help of a handedness-questionnaire given in the AIIMS CNB only right-handed individuals were enrolled in the study. Ratings on items of individual clinical scales were summed up, and a raw score for that scale was generated. Raw scores were converted into T scores for each clinical scale as per the manual of the battery to have better discrimination of the degree of impairment on a particular scale in comparison to normal controls. Further, the T scores of individual clinical scales were converted into an expected T score, taking into consideration age and education of the individual and the formulae given in the manual. If the T score was more than the expected T score, the performance was considered abnormal on a particular clinical scale, and it was suggestive of brain damage. Because there was no T score, in the manual, for the receptive speech scale, only raw scores were used to categorize the performance on this scale for each individual. A raw score of 1 and above on the receptive speech scale indicated the performance to be abnormal irrespective of the age and education of the subject, and a raw score of 0 indicated normal performance. If the T score was higher than the expected T score of the total battery scale, a presence of brain dysfunction in the subject was indicated. To infer the lateralization of this brain dysfunction, the T score of the left hemisphere scale was subtracted from T score of the right hemisphere scale. A positive (+) value, thus obtained, was inferred as right hemisphere dysfunction, while a negative (−) value as left hemisphere dysfunction. However, a conclusion about the lateralization was reached only after analyzing the ranks of eight localizing/lobe scales. The abnormal performance on the pathognomonic scale was taken as severity and acuteness of the dysfunction.

As per the manual, specific combinations of ratings of different items of the battery were chosen specifically for their localizing value, and the raw scores of eight lobes (localizing) scales thus derived were further converted into T scores. The T scores of eight localizing scales were given a rank of 1–8 in descending order. The ranks of left-sided, as well as right-sided localizing scales, were added separately. The sum of ranks on the left side was subtracted from that on the right side. If the difference was less or equal to 8, a diffuse brain dysfunction was interpreted; while a difference of greater was eight indicated some localized lesion in the brain for which the highest two ranks were taken to indicate primary and secondary areas of the brain to be affected.

Statistical analyses
The data were analyzed using the computer software program-Statistical Package for the Social Sciences-version 16.0 (SPSS Inc. Chicago, IL., USA), with different parametric and nonparametric tests, as indicated. Data were checked for normality using the Kolmogorov–Smirnov test. When it was found to be nonnormal, data were analyzed using nonparametric methods. The categorical data were compared using Chi-square tests or Fisher’s exact test as appropriate. The level of significance was taken as P < 0.05 (two-tailed). The steps of analysis were as follows:

Group differences for sample characteristics were examined with ANOVA, independent t-test, and Chi-square test/Fisher’s exact test as applicable. The mean T scores of various scales of AIIMS CNB were compared among chronic schizophrenia patients, alcohol dependents, and normal subjects using Kruskal–Wallis Test and ANOVA wherever applicable. To compare the groups from one another, Post-Hoc (Bonferroni) was done for normally distributed data. For data that were not normally distributed, the critical difference of mean rank was calculated to be 9.308, and intergroup differences were seen by finding whether the difference of mean ranks of two groups on a particular scale was greater or lesser/equal to 9.308. Similarly, the correlation of T scores of clinical scales of AIIMS CNB with some of sociodemographic and clinical details of alcohol dependent patients was done using Pearson’s r correlation for normally distributed data and Spearman’s rho correlation for data not normally distributed.

RESULTS

There was no significant difference in age, education, religion, marital status, occupation, residence, state, socioeconomic status, and family type among the three groups [Table 1].

The negative value of the composite subscale indicated that chronic schizophrenia patients in the present were predominantly of negative subtype [Table 2]. The clinical details of alcohol-dependent patients are given in [Table 2]. There was no significant difference in terms of tobacco abuse and occasional use of other substances such as cannabis and alcohol among three groups (barring alcohol use in the alcohol-dependent group) [Table 4].

The mean T scores of all the clinical scales were significantly higher in chronic schizophrenia patients in comparison to both alcohol dependents and normal subjects as well as these were significantly higher in alcohol dependents in comparison to normal subjects, except some of the clinical scales like visual scale and arithmetic scale which were significantly higher in
chronic schizophrenia patients in comparison to both alcohol dependents and normal subjects, but these were comparable between alcohol dependents and normal controls [Table 5].

Overall, the neuropsychological performance of chronic schizophrenia patients was on one extreme and that of normal subjects on another extreme, while it was intermediate in the alcohol dependents, on all the clinical scales of the AIIMS CNB [Figure 1].

The mean T scores of all the lobe (localizing) scales were significantly higher in chronic schizophrenia patients compared to both alcohol dependents and normal controls. Further, the mean T scores of all these scales were significantly higher in alcohol dependents than normal controls [Table 6].

Overall, the mean values of these scales in the control group were the lowest and in the chronic schizophrenia group the highest, with the alcohol-dependent group placed in between [Figure 2].

Abnormal performance (i.e. T score > Expected T score) on total battery indicated the presence of neuropsychological dysfunction, and it was present in 83.3% of chronic schizophrenia and 36.7% of alcohol dependents but none of the normal subjects [Table 7].

A significantly higher number of chronic schizophrenia patients had abnormal (i.e. brain-damage) performance than alcohol dependents on the basic scales like tactile scale, arithmetic scale, memory scale, intellectual process scale, left hemisphere scale, pathognomonic scale, and total battery scale [Table 8].
All the chronic schizophrenia patients, 90% of alcohol dependents, and 83.3% of normal subjects had lateralization of brain dysfunction to the right hemisphere [Table 9].

Frequency of diffuse Brain Dysfunction in chronic Schizophrenia and Alcohol Dependents patients having abnormal (Brain Damage) Performance on AIIMS CNB is shown in Table 10.

The patients of chronic schizophrenia and alcohol dependence who showed no diffuse brain dysfunction were speculated to have localized or lateralized brain dysfunction, but further analysis was not performed in view of very small number of such patients.

Correlation between T Scores of Clinical Scales of AIIMS CNB and sociodemographic and Clinical Details of Chronic Schizophrenia and alcohol-dependent patients is given in Tables 11 and 12, respectively.

**DISCUSSION**

**Methodological issues and sample characteristics**

Because it was a time-bound study, a sample size of 30 was kept in each of three groups. The purposive sampling technique allowed us to select individuals relevant to this study, and it was convenient and easily accessible as well. It helped us to have the sample with almost nil dropouts during the study. To exclude any bias, all consecutive patients were screened. The strict diagnostic guidelines, review of case notes as well as discussion of diagnoses with the senior psychiatrists, helped us to eliminate the subjective biases while choosing the patients’ groups. Other more stringent sampling method like randomization was not possible because of lack of a total pool of data at one point of time. A similar sampling method has been used in many Indian studies,[22,39] which assessed neuropsychological functioning in different inpatients and outpatients. To improve the homogeneity of the sample of three groups, only male individuals were taken into account.

**Table 2: Clinical details of chronic schizophrenia patients**

| Clinical details of chronic schizophrenic patients | n=30, Mean±SD |
|--------------------------------------------------|---------------|
| Duration of illness (in years)                   | 9.23±8.05     |
| PANSS: Total scale score                         | 64.53±14.79   |
| PANSS: Positive subscale score                   | 11.10±3.87    |
| PANSS: Negative subscale score                   | 19.53±5.01    |
| PANSS: General psychopathology subscale score   | 33.90±9.23    |
| PANSS: Composite subscale score                  | −8.43±5.19    |
| Mode of onset, n (%)                             |               |
| Acute                                            | 2 (6.7)       |
| Insidious                                        | 28 (93.3)     |
| Precipitating factor                             |               |
| Absent                                           | 23 (76.7)     |
| Present                                          | 7 (23.3)      |
| Past medical history                             |               |
| Absent                                           | 26 (86.7)     |
| Present                                          | 4 (13.3)      |
| Past psychiatry history                          |               |
| Absent                                           | 12 (40)       |
| Present                                          | 18 (60)       |
| Family history of mental illness                 |               |
| Absent                                           | 23 (76.7)     |
| Present                                          | 7 (23.3)      |
| Inclusionary subtypes                            |               |
| Positive subtype                                 | 1 (3.3)       |
| Negative subtype                                 | 29 (96.7)     |
| Exclusionary subtypes                            |               |
| Negative subtype | | 11 (36.7) |
| Neither (positive or negative) subtype           | 19 (63.3)     |

PANSS – Positive and negative syndrome scale; SD – Standard deviation

**Table 3: Clinical details of alcohol dependence cases**

| Clinical details of alcohol dependents            | n=30, mean±SD |
|--------------------------------------------------|---------------|
| Age of onset of alcohol intake (years)            | 24.53±6.26    |
| Total duration of alcohol intake (in years)       | 9.20±5.04     |
| Duration of alcohol dependence (years)            | 5.57±3.44     |
| Interval between last alcohol intake and neuropsychological assessment (days) | 23.6±6.82 |
| SADQ total score                                  | 27.40±8.82    |
| Severity level on SADQ total score (Mild <16; Moderate=16-30; Severe ≥31), n (%) |               |
| Moderate                                          | 19 (63.3)     |
| Severe                                            | 11 (36.7)     |
| Past medical history, n (%)                       |               |
| Absent                                           | 25 (83.3)     |
| Present                                          | 5 (16.7)      |
| Past psychiatry history, n (%)                    |               |
| Absent                                           | 23 (76.7)     |
| Present                                          | 7 (23.3)      |
| Family history of mental illness, n (%)           |               |
| Absent                                           | 15 (50)       |
| Present                                          | 15 (50)       |

SADQ – Severity of Alcohol Dependence Questionnaire; SD – Standard deviation
Table 4: Comparison of substance use details of chronic schizophrenia patients, alcohol dependence cases, and normal subjects

| Substance use details                  | Chronic schizophrenia patients (n=30), n (%) | Alcohol dependents (n=30), n (%) | Normal Subjects (n=30), n (%) | χ² (df=1) | P  |
|---------------------------------------|--------------------------------------------|---------------------------------|-------------------------------|-----------|----|
| Tobacco abuse                         |                                            |                                 |                               |           |    |
| Absent                                | 15 (50)                                    | 14 (46.7)                       | 25 (83.3)                     | 0.067     | 0.796 |
| Present                               | 15 (50)                                    | 16 (53.3)                       | 5 (16.7)                      |           |    |
| Occasional use of other substances    |                                            |                                 |                               |           |    |
| Absent                                | 24 (80)                                    | 27 (90)                         | 28 (93.3)                     | 1.176     | 0.278 |
| Present                               | 6 (20)                                     | 3 (10)                          | 2 (6.7)                       |           |    |

Table 5: Comparison of T scores of Clinical Scales of AIIMS Comprehensive Neuropsychological Battery among Chronic schizophrenia Patients (A), Alcohol Dependence patients (B), and Normal Subjects (C)

| Clinical scales                           | Means±SD | H/F (df=2) | Post hoc |
|-------------------------------------------|----------|------------|----------|
| T - score (motor scale)                   | 118.17±22.37 | 68.72±14.83 | 57.735*** | A>B > C |
| T - score (tactile scale)                 | 110.34±23.35 | 74.42±10.58 | 48.77±9.52 | 66.23***  | A>B > C |
| T - score (visual scale)*                 | 85.90±11.24 | 59.60±11.94 | 57.67±9.05 | 10.146**  | A>B > C |
| Total score (receptive speech scale)*     | 83.80±19.60 | 74.10±18.52 | 56.20±16.00 | 17.941*** | A>B > C |
| T - score (expressive speech scale)       | 83.23±19.12 | 64.17±21.36 | 50.87±14.18 | 25.37***  | A>B > C |
| T - score (reading scale)*                | 71.67±26.71 | 52.97±17.81 | 44.33±13.75 | 25.40***  | A>B > C |
| T - score (writing scale)*                | 71.30±15.19 | 55.73±19.76 | 51.40±15.44 | 32.08***  | A>B > C |
| T - score (arithmetic scale)*             | 74.10±11.01 | 60.47±10.04 | 52.27±8.35  | 37.54***  | A>B > C |
| T - score (memory scale)                  | 70.47±13.93 | 56.37±19.64 | 50.23±16.57 | 30.66***  | A>B > C |
| T - score (intellectual process scale)*   | 123.37±20.13 | 90.73±14.64 | 71.93±10.24 | 61.42***  | A>B > C |
| T - score (right hemisphere scale)*       | 100.06±17.42 | 76.50±12.61 | 59.00±8.78  | 76.85***  | A>B > C |
| T - score (pathognomonic scale)           | 94.77±26.77 | 68.10±14.22 | 57.47±7.33  | 34.72***  | A>B > C |
| T - score (total battery)*                | 102.57±20.71 | 74.93±12.79 | 61.73±17.61 | 52.08***  | A>B > C |

***Significant at P<0.001 (Two-tailed) Data without normal distribution so implies H (Kuskal–Wallis Test). SD – Standard deviation; AIIMS – All India Institute of Medical Science

Table 6: Comparison of lobe (localizing) scales of AIIMS neuropsychological battery among chronic schizophrenia patients (A), Alcohol Dependence patients (B), and Normal Subjects (C)

| T-score of lobe (localizing) scales | Means±SD | H/F (df=2) | Post hoc |
|------------------------------------|----------|------------|----------|
| Left frontal scale*                | 87.27±12.50 | 57.80±17.17 | 38.48***  | A>B > C |
| Left sensory motor scale           | 90.83±12.60 | 50.27±17.83 | 49.58***  | A>B > C |
| Left parieto-occipital scale       | 81.03±12.83 | 53.00±14.73 | 23.85***  | A>B > C |
| Left temporal scale*               | 81.23±12.31 | 50.40±17.08 | 39.06***  | A>B > C |
| Right frontal scale                | 98.63±18.58 | 64.20±18.57 | 42.58***  | A>B > C |
| Right sensory motor scale*         | 96.90±12.94 | 49.62±17.14 | 59.68***  | A>B > C |
| Right parieto-occipital scale      | 79.07±15.32 | 57.67±14.11 | 12.995*** | A>B > C |
| Right temporal scale               | 86.80±15.33 | 59.13±10.33 | 27.099*** | A>B > C |

*Data without normal distribution, so implies H (Kuskal–Wallis Test). ***Significant at P<0.001 (Two-tailed) SD – Standard deviation; AIIMS – All India Institute of Medical Science

The study. The inclusion of only males was influenced by the observations made in different neuropsychological studies indicating gender difference in neuropsychological profiles of both schizophrenia patients[40] and alcohol dependents.[41,42]

The availability of the AIIMS CNB (Adult Form) in Hindi was an advantage as Hindi was the mother tongue of almost all the participants. Among the chronic schizophrenia patients and alcohol-dependent patients, it was administered only after they were settled and cooperative. For both the patients’ groups, last dose of medication was taken at least 6 h before the testing. The battery was administered to the patients usually in 2–3 sessions spread over 2 days to minimize the effect of fatigue and inattentiveness. However, for the normal subjects a single session sufficed.
The majority (63%) of the patients of alcohol dependence in our study were of moderate severity [Table 3]. The mean duration of the interval between the last intake of alcohol and neuropsychological assessment in our study was about 4 (range: 14–41 days). The most significant determinant of the presence of cognitive deficits in persons recovering from alcoholism is the time elapsed since their last drink. Alcohol-dependent patients with an intermediate-term abstinence period have been mentioned to perform better than those in acute detoxification period, but worse than those in the long-term abstinence period. The majority of alcohol-dependent patients in this study fall in the intermediate-term abstinence period, which begins after detoxification and extends through the first 2 months of abstinence.[44] This study found that in almost half of the patients of schizophrenia (50%) and alcohol dependence (53.3%)

**Table 7: Frequency of Abnormal Performance [i.e. T score > expected T score] on the clinical scales of AIIMS neuropsychological battery among chronic schizophrenia patients, alcohol dependence patients, and normal subjects**

| Abnormal performance (i.e. T score > expected T score) on clinical scales | Chronic schizophrenia patients (n=30), n (%) | Alcohol dependents (n=30), n (%) | Normal subjects (n=30), n (%) | $\chi^2$ (df=2) |
|---|---|---|---|---|
| Motor scale | 30 (100) | 25 (83.3) | 14 (46.7) | 24.969*** |
| Tactile scale | 30 (100) | 26 (86.7) | 0 (0) | 75.325*** |
| Visual scale | 12 (40) | 8 (26.7) | 1 (3.3) | 11.553** |
| Receptive speech scale | 28 (93.3) | 24 (80) | 11 (36.7) | 25.079*** |
| Expressive speech scale | 22 (73.3) | 17 (56.7) | 6 (20) | 17.867*** |
| Reading scale | 16 (53.3) | 11 (36.7) | 1 (3.3) | 18.145*** |
| Writing scale | 10 (33.3) | 5 (16.7) | 0 (0) | 12.000** |
| Arithmetic scale | 15 (50) | 3 (10) | 0 (0) | 26.250*** |
| Memory scale | 17 (56.7) | 3 (10) | 0 (0) | 31.757*** |
| Intellectual process scale | 14 (46.7) | 0 (0) | 0 (0) | 33.158*** |
| Right hemisphere scale | 30 (100) | 27 (90) | 14 (46.7) | 28.955*** |
| Left hemisphere scale | 29 (96.7) | 14 (46.7) | 1 (3.3) | 52.381*** |
| Pathognomonic scale | 25 (83.3) | 15 (50) | 2 (6.7) | 35.625*** |
| Total battery (neuropsychological dysfunction) | 25 (83.3) | 11 (36.7) | 0 (0) | 43.611*** |

**Table 8: Frequency of abnormal performance (i.e., T score > expected T score) on the clinical scales of AIIMS neuropsychological battery among chronic schizophrenia patients, and alcohol dependence patients**

| Abnormal performance (i.e. T score > expected T score) on clinical scales | Chronic schizophrenia patients (n=30), n (%) | Alcohol dependents (n=30), n (%) | $\chi^2$ (df=2) |
|---|---|---|---|
| Motor scale | 30 (100) | 25 (83.3) | 5.455 |
| Tactile scale | 30 (100) | 26 (86.7) | 4.286* |
| Visual scale | 12 (40) | 8 (26.7) | 1.200 |
| Receptive speech scale | 28 (93.3) | 24 (80) | 1.986 |
| Expressive speech scale | 22 (73.3) | 17 (56.7) | 7.500** |
| Reading scale | 16 (53.3) | 11 (36.7) | 3.158 |
| Writing scale | 10 (33.3) | 5 (16.7) | 0.180 |
| Arithmetic scale | 15 (50) | 3 (10) | 0.200 |
| Memory scale | 17 (56.7) | 3 (10) | 0.800 |
| Intellectual process scale | 14 (46.7) | 0 (0) | 0.000 |
| Right hemisphere scale | 30 (100) | 27 (90) | 0.000 |
| Left hemisphere scale | 29 (96.7) | 14 (46.7) | 0.000 |
| Pathognomonic scale | 25 (83.3) | 15 (50) | 0.000 |
| Total battery (neuropsychological dysfunction) | 25 (83.3) | 11 (36.7) | 1.832 |

**Significant at $P<0.05$ (two-tailed); ***Significant at $P<0.001$ (two-tailed). AIIMS – All India Institute of Medical Science**

All the participants in this study were comparable in terms of their demographic characteristics providing homogeneity of study samples allowing better comparison of neuropsychological dysfunction [Table 1]. None of the previous studies have mentioned any link of these sociodemographic details to the neuropsychological performance except that of age and education. Mean duration of illness in schizophrenia patients of about 9 years signifies the chronic nature of their illness. According to strict criteria of Crow,[37] only 36.7% of chronic schizophrenia patients were of a negative type and the rest were neither negative nor positive type [Table 2].
Table 9: Comparison of Lateralization of neuropsychological dysfunction on AIIMS comprehensive neuropsychological battery among chronic schizophrenia patients, alcohol dependence patients, and normal subjects

| Lateralization of brain dysfunction | Chronic schizophrenia patients (n=30), n (%) | Alcohol dependents (n=30), n (%) | Normal subjects (n=30), n (%) | Fishers exact test |
|-----------------------------------|---------------------------------------------|---------------------------------|-------------------------------|--------------------|
| Left hemisphere                   | 0 (0)                                       | 3 (10)                          | 5 (16.7)                      | P=0.090 (NS)       |
| Right hemisphere                  | 30 (100)                                    | 27 (90)                         | 25 (83.3)                     |                    |

*Based on the lateralization index. NS – Not significant

Table 10: Frequency of presence of chronic schizophrenia patients and alcohol dependence patients who had abnormal (brain damage) performance

| Diffuse brain dysfunction | Chronic schizophrenia patients (n=25), n (%) | Alcohol dependents (n=111), n (%) | Fishers exact test |
|--------------------------|---------------------------------------------|---------------------------------|--------------------|
| Absent                   | 1 (4)                                       | 3 (27.28)                      | P=0.0756 (NS)      |
| Present                  | 24 (96)                                     | 8 (72.72)                      |                    |

Table 11: Correlation between T scores of clinical scales of AIIMS comprehensive neuropsychological battery and sociodemographic and clinical details of chronic schizophrenia patients (n=30)

| T scores of clinical scales | Age (years) | Years of education | Duration of illness (years) | riS | PANSS |
|-----------------------------|-------------|--------------------|-----------------------------|-----|-------|
| Motor scale                 | 0.105       | -0.569**           | 0.162                       | 0.324 | 0.054 | 0.395* | 0.281 |
| Tactile scale               | 0.105       | -0.363*            | 0.043                       | 0.480* | 0.306 | 0.519** | 0.384* |
| Visual scale                | -0.072      | -0.451*            | -0.018                      | 0.138 | 0.075 | -0.007 | 0.186 |
| Receptive speech scale*     | 0.024       | -0.397*            | 0.084                       | 0.597** | 0.450* | 0.610** | 0.480** |
| Expressive speech scale*    | -0.153      | -0.602***          | -0.102                      | 0.486** | -0.022 | 0.433* | 0.565** |
| Reading scale               | -0.015      | -0.456*            | -0.071                      | 0.373* | 0.043 | 0.377* | 0.395* |
| Writing scale               | -0.158      | -0.720***          | -0.200                      | 0.733** | 0.330 | 0.500** | 0.732*** |
| Arithmetic scale            | -0.072      | -0.562**           | 0.026                       | 0.608*** | 0.362* | 0.669*** | 0.502** |
| Memory scale                | -0.145      | -0.528**           | -0.165                      | 0.680** | 0.403* | 0.590** | 0.601*** |
| Intellectual process scale* | -0.175      | -0.715***          | -0.128                      | 0.616*** | 0.350 | 0.542** | 0.612** |
| Right hemisphere scale*     | 0.063       | -0.577***          | -0.060                      | 0.560** | 0.295 | 0.544** | 0.527** |
| Left hemisphere scale       | 0.034       | -0.579**           | 0.102                       | 0.608*** | 0.246 | 0.643** | 0.522** |
| Pathognomonic scale         | 0.161       | -0.349             | -0.074                      | 0.392* | 0.213 | 0.430* | 0.306 |
| Total battery               | 0.055       | -0.595***          | -0.048                      | 0.609*** | 0.278 | 0.567** | 0.554** |

*Significant at P<0.05 (two-tailed); **Significant at P<0.01 (two-tailed); ***Significant at P<0.001 (two-tailed); °Data without normal distribution so implies riS (Spearman’s rho).

r – Pearson’s r; PANSS – Positive and Negative Syndrome Scale; AIIMS – All India Institute of Medical Science

tobacco abuse was present. Tobacco abuse can adversely impact neuropsychological performance. Comorbid chronic smoking not only affects neuropsychological performance in that time but also has an impact on the recovery of neuropsychological dysfunctions, especially in alcohol dependents during abstinence. However, a comparable presence of it in the participants of all three groups of our study nullifies any anticipated difference in neuropsychological dysfunctions due to tobacco abuse in the current study.

Occasional intake of other substances consisted commonly of alcohol, and less commonly of sleeping pills, abuse of various cough syrups, etc., was present in 20% of chronic schizophrenia patients, 10% of alcohol dependents, and 6.7% of normal controls. Durazzo et al. found that 64% of alcohol dependents had at least one medical, psychiatric, or substance-abuse comorbidity (excluding smoking). They found that smoking status (smoker or nonsmoker) and age were significant independent predictors of cognitive efficiency, general intelligence, postural stability, processing speed, and visuospatial memory after age-normed adjustment and control for estimated premorbid verbal intelligence, education, alcohol consumption, and medical, psychiatric, and substance-misuse comorbidities.

Neuropsychological dysfunctions in chronic schizophrenia patients in comparison to normal subjects

Frequency of dysfunctions

The finding of neuropsychological dysfunction in 83.3% of chronic schizophrenia patients (compared to none of the normal controls) is in agreement with earlier studies.
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Haldar[22] reported that 76.6% of schizophrenia patients had neuropsychological dysfunctions according to the scale elevation criteria for the general population,[46] whereas 66.7% of them according to scale elevation criteria for schizophrenia patients.[47] Similarly, two other studies found neuropsychological dysfunction on LNNB in 65% and 80% of schizophrenia patients, respectively.[24,23] In addition, some more recent studies using a variety of neuropsychological tests reported that 70% to 85% of schizophrenia patients have abnormal neuropsychological profiles.[48-52] A meta-analysis of 204 studies found cognitive impairment in 75% of schizophrenia patients.[53]

Location of dysfunctions

The finding of diffuse brain dysfunction in 90% of chronic schizophrenia patients who had neuropsychological dysfunction supports the view that schizophrenia has no demonstrable lesion in the brain. A precise delineation of the neuropathology underlying schizophrenia in general or its associated neurocognitive deficits in particular has remained elusive despite efforts extending back over a century.[24,53] Neuropsychological dysfunctions in psychiatric or neuropsychiatric conditions are not associated with clearly defined brain injuries and are instead hypothesized to result from the cumulative effects of neurodegenerative disease, neurotransmitter malfunctions, developmental hypoplasias, diffuse white matter lesions, or brain volume gains and losses.[25]

Severity of dysfunctions

The finding of severe neuropsychological dysfunction in 83.3% of chronic schizophrenia patients is somewhat higher than the findings of previous studies.[22-24] The reason for this might be the emphasis in our study to include inpatients of chronic schizophrenia (and thus more of negative subtype), while earlier studies had more of paranoid schizophrenia with no emphasis on chronicity in the duration of illness in sample selection. Generally, there is an association of greater severity of illness with greater neuropsychological impairment across different populations of schizophrenia patients, and the degree of neuropsychological dysfunction will certainly depend on the population of patients studied.[57,58] For example, one study found similarities in the severity of cognitive dysfunction between a first-episode cohort and chronically ill schizophrenia outdoor patients, but large differences between these two groups and the third group of chronically ill inpatients of schizophrenia.[57]

Domains of dysfunctions in chronic schizophrenia

Motor dysfunctions

A poorer performance on measures of motor functioning of the AIIMS CNB was seen in all the chronic schizophrenia patients versus 46.7% of normal subjects. Similarly, impaired performance on the motor scale of LNNB was reported in 26.7% of patients with paranoid schizophrenia.[22] Similar findings have been reported in other studies both in India[23,24,59] and abroad.[60] The finding of our study is consistent with the observation that motor dysfunctions in terms of motor incoordination, clumsiness, and soft neurological signs are common in schizophrenia.[61] Our study does not exclude the confounding factor of effects of neurolipotropic medications on the performance of motor tasks, but it was ensured that the patients were free of side effects of psychotropic medication at the time of administration of the AIIMS CNB.

Table 12: Correlation between T scores of clinical scales of AIIMS neuropsychological battery and socio-demographic and clinical details of alcohol dependence patients (n=30)

| T scores of clinical scales | Age (years) | Years of education | Age of onset of alcohol (years) | Total duration of alcohol intake (years) | Duration of alcohol dependence (years) | SADQ score |
|---------------------------|-------------|--------------------|--------------------------------|----------------------------------------|---------------------------------------|------------|
| Motor scale               | 0.344       | -0.394*            | 0.245                          | 0.342                                  | 0.273                                 | 0.294      |
| Tactile scale*            | 0.133       | -0.118             | 0.035                          | 0.239                                  | 0.257                                 | 0.146      |
| Visual scale*             | 0.127       | -0.196             | 0.018                          | 0.133                                  | 0.157                                 | 0.244      |
| Receptive speech scale*   | 0.142       | -0.315             | 0.022                          | 0.168                                  | 0.144                                 | 0.562**    |
| Expressive speech scale   | 0.017       | -0.544**           | -0.123                         | 0.179                                  | 0.142                                 | 0.452*     |
| Reading scale*            | -0.070      | -0.476**           | -0.166                         | 0.106                                  | 0.033                                 | 0.332      |
| Writing scale*            | 0.066       | -0.514**           | -0.184                         | 0.270                                  | 0.143                                 | 0.466**    |
| Arithmetic scale*         | -0.059      | -0.433*            | -0.275                         | 0.294                                  | 0.198                                 | 0.632***   |
| Memory scale              | 0.140       | -0.408*            | 0.041                          | 0.127                                  | 0.071                                 | 0.228      |
| Intellectual process scale| 0.150       | -0.649***          | -0.083                         | 0.223                                  | 0.199                                 | 0.433*     |
| Right hemisphere scale*   | 0.344       | -0.249             | 0.044                          | 0.288                                  | 0.303                                 | 0.298      |
| Left hemisphere scale*    | 0.222       | -0.579**           | 0.082                          | 0.200                                  | 0.213                                 | 0.445*     |
| Pathognomonic scale       | 0.355       | -0.064             | 0.090                          | 0.342                                  | 0.351                                 | 0.275      |
| Total battery*            | 0.283       | -0.557**           | 0.038                          | 0.246                                  | 0.188                                 | 0.457*     |

*Significant at P<0.05 (two-tailed); **Significant at P<0.01 (two-tailed); ***Significant at P<0.001 (two-tailed); Data without normal distribution so implies rs (Spearman’s rho); r: Pearson’s r; SADQ – Severity of Alcohol Dependence Questionnaire; AIIMS – All India Institute of Medical Science
**Tactile dysfunctions**

Poorer performance on measures of tactile functioning was observed in all the chronic schizophrenia patients versus none of the normal subjects, which is in agreement with the findings of few earlier Indian studies.[22,59] Impaired somatosensory perceptions, including fine motor touch, temperature, pain (nociception), movement, tension, and vibration are common in schizophrenia.[62,63] The tactile scale of the AIIMS CNB measures similar constructs. Somatosensory deficits may have a profound impact on the quality of life, including the performance of jobs that require the use of tools, such as a car mechanic and carpenter as well as more academic jobs, such as musician, painter, and sculptor. These jobs require accurate processing of somatosensory feed-back to guide hand movements. Recently, tactile dysfunctions in schizophrenia have also been correlated with functional imaging studies. Huang et al.[64] used magnetoencephalography to identify neural networks that support attention to somatosensory stimuli in healthy adults and abnormalities in these networks in patients with schizophrenia. They have found a link of attention-related somatosensory deficits to dysfunctions in both sensory-motor and frontoparietal-temporal networks in schizophrenia. A model of somatosensory dysfunction in schizophrenia can be used to guide the development of treatments to reduce somatosensory related cognitive deficits and to improve the quality of life for these individuals.

**Visual dysfunctions**

There was a poor performance on measures of visual functioning in 40% of chronic schizophrenia patients versus 3.3% of normal subjects. This finding is supported by some earlier Indian studies.[22-24,59]

**Receptive speech dysfunctions**

There was a significant difference of receptive speech dysfunctions between chronic schizophrenia patients and normal controls. Many of the earlier studies which employed the LNNB also found receptive speech dysfunctions in schizophrenia patients.[22,23,59,60]

**Expressive speech dysfunctions**

A significantly higher number of chronic schizophrenia patients showed expressive speech dysfunctions in comparison to normal subjects (73.3% vs. 20%) on the AIIMS CNB. A similar result of dysfunctions of expressive speech was found in some earlier Indian studies[22,59] but not by others.[23]

Apart from receptive or expressive speech dysfunctions, the language dysfunctions in schizophrenia, as such have always been a topic of controversy with no clear pathogenesis. The collective findings clearly indicate that the functional integrity of the language system is compromised in schizophrenia, although the key brain regions and cellular mechanisms responsible for this dysfunction remain to be determined. Some alternative explanations like language dysfunctions as an epiphenomenon secondary to disturbances of thought[64] or formal thought disorder[65] have also been mentioned in the literature. schizophrenia and aphasic language can be phenomenologically similar, but the patients of schizophrenia, unlike aphasics, have no difficulties with simple language measures of syntax, fluency, or naming.[66]

**Reading dysfunctions**

Significantly more number of schizophrenia patients had reading dysfunctions in comparison to normal subjects (53.3% vs. 3.3% respectively). This was supported to some extent by the findings of Haldar,[22] who reported that 13% of paranoid schizophrenia patients had reading dysfunctions. However, Mishra[59] found that the difference between schizophrenia and normal groups was significant on all scales of LNNB except reading and arithmetic scales. According to Golden et al.,[67] apart from left cerebral hemisphere damage, the reading dysfunctions may result from spatial disruption as well as neglect of the left side. However, we could not establish any such cause in our study.

**Writing dysfunctions**

While none of the normal subjects performed poorly on the writing scale, 33.3% of schizophrenia patients had writing dysfunctions. This finding is supported by some earlier studies[22,59] but not by others.[23,24]

**Arithmetic dysfunctions**

In the present study, 50% of chronic schizophrenia patients had arithmetic dysfunctions compared to none of the normal controls. Impaired performance on the arithmetic scale of LNNB is mentioned by some previous studies[22,23] but not by others.[24,59]

**Memory dysfunctions**

While none of the normal subjects had poor performance on measures of memory, 56.7% of chronic schizophrenia patients had memory dysfunctions. Thus, our study supports the well-known view that memory dysfunctions are among core neuropsychological dysfunctions in schizophrenia. Memory dysfunctions in schizophrenia patients have been reported by studies conducted both in India[22,24,59,68,69] and abroad.[28,70] As in our study, all the patients of chronic schizophrenia were on antipsychotic medication at the time of evaluation in another study, with a larger sample of 100 each in patient and control groups. This study also showed dysfunctions on multiple measures of attention and memory in schizophrenia.
A significant deficit on tests of attention, concentration, and verbal and visual memory was observed even in schizophrenia patients in remission. Using the California Verbal Learning Test it was demonstrated that schizophrenia patients have adequate retention of previously learned information (savings or storage), but are deficient in initially encoding information (acquisition) and in retrieval (the amount recalled is less than the amount of information recognized).

**Intellectual processes dysfunctions**

In comparison to no abnormal performance by any of normal subjects, 46.7% of chronic schizophrenia patients had intellectual processes dysfunctions. This finding is supported by some earlier work. A significant number of patients of paranoid schizophrenia showed impairment in simple and complex integrated functions on item interpretation of LNNB. The intellectual processes scale of the AIIMS CNB encompasses tasks such as general information; comprehension of social situations; explanation of popular proverbs; ability to determine opposites, find out similarities and differences, and form analogies and concepts; logical reasoning for numbers; and identifying missing elements in a complex geometric configuration. However, in the absence of item interpretation of the scale, we could not comment on specific neuropsychological sub-domains of intellectual process which had been affected in chronic schizophrenia patients. However, a deficit performance on the scale as a whole appears closer to findings that significant impairment of fronto-executive functions is present in schizophrenia patients either in remission or on antipsychotic medication at the time of evaluation. The findings of intellectual processes dysfunctions in chronic schizophrenia patients are further supported by a recent Indian study which found that patients of schizophrenia or schizoaffective disorder showed more cognitive impairment than controls on tasks of the Trail-making test, a test for executive functions.

**Correlates of neuropsychological dysfunctions in chronic schizophrenia**

Overall, it appears that academic achievement, as well as the presence and severity of psychotic symptoms, especially the negative symptoms, significantly affect neuropsychological functioning in chronic schizophrenia patients [Table 11].

Few research works done both in India and abroad support the findings of our study. Neurocognitive impairment was found in positive and negative schizophrenia in motor, tactile, receptive, expressive, and arithmetic scales of LNNB. Negative schizophrenia showed greater cognitive dysfunction compared to positive schizophrenia. Further, it was claimed that the stronger negative symptomatology in schizophrenia is associated with worse neuropsychological performance. The lack of relationship of age, as well as the duration of illness to the neuropsychological functioning in the patients, supports the view that neuropsychological dysfunctions in schizophrenia are core features which remain relatively stable over time.

An earlier Indian study concluded that the neurocognitive profile of attention, executive function, and memory of chronic schizophrenia patients resembled those of patients in developed countries, and these neuropsychological deficits are related to education, age, duration of illness, and presence of positive and negative symptoms. However, our study differs to some extent from the previous study regarding the relationship of neuropsychological deficits and details of patients such as age, education, duration of illness, positive/negative symptoms. This variation of correlation findings is not uncommon because these depend on a variety of factors, including sample characteristics, neuropsychological measures applied, etc. The results of some other studies are contradictory. found dysfunctions of different dimensions of executive functions in outpatients of schizophrenia, but no significant relationship with age, duration of illness, or scores of PANSS. also reported that schizophrenia patients fared worse on almost all the tests of memory, executive function, and attention compared to normal controls, but no relationship was found between age, duration of illness, number of years of education, and cognitive function. From the above, it appears that neuropsychological dysfunctions are characteristic and core features of schizophrenia, but findings regarding the relationships of these with various variables like age, education, duration of illness, symptoms (positive/negative), etc., are not consistent.

**Neuropsychological dysfunctions in alcohol dependence patients in comparison to normal subjects**

**Frequency of dysfunctions**

Overall, 36.7% of alcohol dependents had neuropsychological dysfunctions compared to none of the normal subjects. The finding of this study is in agreement with previous studies.

**Locations of dysfunctions**

A pattern of diffuse brain dysfunction was found in 72.72% of the alcohol dependents, who had impaired performance on neuropsychological assessment. Similarly, an earlier study found that chronic alcoholics suffered from a mild diffuse-generalized brain dysfunction at 3 weeks of abstinence and persisted thereafter for up to at least 11 weeks of abstinence. In our study too, the mean duration of abstinence, after which neuropsychological assessment was done, was of around 3 weeks. Thus, our study supports the view that the most significant determinant of the presence...
of neuropsychological deficits in persons recovering from alcoholism is the time elapsed since their last drink.\[43]\n
The finding of our study supports the view of other researchers\[8,12,41]\nthat although alcoholics have diffuse damage in the cerebral cortex of both hemispheres of the brain, neuropathological studies performed on the brains of deceased patients as well as findings derived from neuroimaging studies of living brains point to increased susceptibility of frontal brain systems to alcoholism-related damage.\n
A selective review concluded that uncomplicated alcoholics (i.e. those without co-morbidities or alcohol-induced persistent amnestic/dementia changes) have lesser brain damage compared to complicated alcoholics. Diffuse brain shrinkage in uncomplicated alcoholics can largely be accounted for by the loss of white matter, and some of this damage is reversible. Alcohol-related neuronal loss was documented in the superior frontal association cortex, hypothalamus (supraoptic and paraventricular nuclei), and cerebellum. Many of the regions that are normal in uncomplicated alcoholics are damaged in those with the Wernicke-Korsakoff syndrome. The dendritic and synaptic changes documented in uncomplicated alcoholics, together with receptor and transmitter changes, may explain functional changes and cognitive deficits that precede the more severe structural neuronal changes.\[79]\n
In terms of diffuse brain dysfunctions in alcoholics, the findings of our study are further supported by a study that compared alcohol dependents (either smoking or nonsmoking) and nonsmoking light drinkers with regional diffusion tensor imaging, magnetic resonance imaging and spectroscopy at 1 week and 1 month of abstinence. No consistent patterns of association between measures obtained with different imaging modalities were found, either cross-sectionally or longitudinally. However, a significant white matter improvements with abstinence from alcohol was demonstrated.\[89]\n
Severity of dysfunctions

A significantly greater number of alcohol-dependent patients (50%) had severe neuropsychological dysfunctions in comparison to normal subjects (6.7%). This finding is supported by Chmielewski and Golden\[32]\nwho found a raised score of the pathognomonic scale of the LNNB in alcoholics in comparison to age— and education—matched controls. Similarly, Bates et al.,\[81]\nreported that between 50% and 80% of individuals with alcohol use disorders experience mild to severe neuropsychological impairment. They argued that neuropsychological impairment is an important source of individual difference affecting many aspects of addiction treatment, but empirical tests of the direct influence of impairment on treatment outcome have yielded weak and inconsistent results.

Domain-wise dysfunctions

Motor dysfunctions

A significantly higher number of alcohol dependents (83.3%) had motor dysfunctions in comparison to normal subjects (46.7%). The mean duration of abstinence, after which neuropsychological assessment was done, was 3 weeks. This finding supported partially by an earlier study that found that all patients at 2 weeks of abstinence performed significantly worse than healthy controls on motor functions like motor speed, muscle strength, and visuomotor coordination. They further concluded that the motor functioning to be impaired on neuropsychological assessment, there should be long histories of alcohol abuse.\[82]\nFew other studies support the findings in our study. One study demonstrated deficits of the flexibility of closure and complex psychomotor coordination\[79]\nwhile another found disturbances in gait and balance but relative sparing of upper-limb strength and speed at the abstinence of 3.6 months.\[82]\n
Tactile dysfunctions

There was a significant difference of tactile dysfunctions between alcohol dependents and normal subjects in the present study. However, earlier studies in abstinent alcoholics did not report tactile dysfunctions.\[32,33]\n
Visual dysfunctions

A significantly higher number of alcohol dependents (26.7%) had visual dysfunctions in comparison to normal subjects (3.3%). This finding is supported by an earlier work which found that the alcohol dependents differed from age- and education-matched controls on visual scale dysfunction.\[82]\nAnother study reported that both male and female alcohol dependents, who were abstinent for an average of 3.6 months, had significantly more visuospatial dysfunctions than matched normal controls.\[82]\nIn 489 college students, it was found that participants with alcohol use disorders showed deficits in visuospatial ability, while those with alcohol dependence showed deficits in both visuospatial ability and motor speed.\[93]\n
Receptive speech dysfunctions

The finding of significant difference of receptive speech dysfunctions between alcohol dependents and normal controls is in accordance with earlier work who found that alcoholics differed from age – and education – matched controls on the receptive language scale of the LNNB.\[53]\n
Expressive speech dysfunctions

A significantly higher number of alcohol dependents (56.7%) had visual dysfunctions in comparison to normal subjects (20%) in the present study. This finding is not supported by an earlier
study which did not find any difference on expressive speech scale of the LNNB in alcoholics in comparison to age – and education – matched controls.[32]

**Reading dysfunctions**

Reading dysfunction in alcohol dependents (36.7%) was significantly higher compared to normal subjects (3.3%). The findings of Moss et al. support our study only partially because of differences in sample characteristics. They reported adolescent alcohol abusers who demonstrated inferior performance in measures of reading recognition, total reading, and spelling achievement compared with controls, were having lower IQ scores.[84]

**Writing scale**

Writing dysfunction in alcohol dependents (16.7%) was significantly higher than normal subjects (0%). This finding is not supported by a previous study that did not find any difference in the writing scale of the LNNB in alcoholics and age- and education-matched controls.[32]

**Arithmetic dysfunctions**

Arithmetic dysfunction (10%) was significantly higher in alcohol dependents, compared to normal subjects (0%). This finding is in accordance with an earlier study which found that alcoholics differed from age – and education – matched controls on the arithmetic scale of the LNNB.[22] One explanation for subtle arithmetic dysfunctions in patients of long-term alcohol dependence during abstinence is the subtle but persistent changes in attention and orientation. As measured with the auditory event-related potential component P3.[89]

**Memory dysfunctions**

Memory dysfunction in alcohol dependents (10%) was significantly higher compared to normal subjects (0%). Memory dysfunctions have been reported in various studies[32,42,86] where abstinent chronic alcoholics were assessed with tests of memory. The presence of memory dysfunctions in only 10% of the patients of our study may be due to tasks in the memory scale per se. This logic is supported by the work of Leber et al.[87] who specifically examined learning and memory in two groups of alcoholics abstinent for 3 and 11 weeks, respectively, and a matched control group. They found no difference among the three groups in verbal-learning abilities, but on a visuospatial learning task and on memory for designs. Further, the works of Sullivan et al.[82] and Ambrose et al.[13] emphasize impairment of working memory in abstinent alcoholics. Thus these studies support our finding partially.

**Intellectual processes dysfunctions**

In our study, none of the control subjects or alcohol dependents showed abnormal performance on the intellectual processes scale. This finding is not in accordance with an earlier study that found that alcoholics differed from age – and education – matched controls on the intelligence scale of the LNNB.[32]

A longitudinal study of alcohol dependents and matched controls tested at 7 weeks and 13 months after detoxification, found that alcoholics perform worse than controls on tasks like abstracting and problem-solving skills at least an initial assessment.[88] One explanation for an apparently intact intellectual functioning in alcohol dependents of our study may be the strict criteria for sample selection with special emphasis to exclude those with any evidence of alcohol-induced persistent amnesia or dementia. This view is further strengthened by a study which compared healthy abstinent alcohol-dependent subjects with normal controls and concluded that despite frontal lobe dysfunctions in abstinent alcohol-dependent subjects, both the groups had above-average WAIS-R IQ scores.[9] Similarly, another study found that despite deficit performance on tests of nonverbal reasoning, alcohol-dependent patients showed preserved functions in verbal intelligence.[7] A test-retest study with alcohol dependents found that the patients at 3 weeks postdetoxification showed improvement of dysfunction in working memory, verbal fluency, and verbal inhibition that were found during detoxification. However, patients remained deteriorated in terms of nonverbal executive function tasks (mental flexibility and planning ability) even at 3 weeks of abstinence after detoxification.[89]

The findings of the present study in terms of motor, expressive speech, reading, writing, arithmetic, and memory dysfunctions in alcohol dependents are in accordance with those of Eckardt et al.[86] They subjected 101 alcohol-dependent individuals aged 18–35 years, who had a history of excess alcohol consumption for 6 years, to an extensive battery of neuropsychological tests, and worse performance was seen in measures of memory, abstract thought, and language. Interestingly, the mean age (33.83 ±6.59 years) and mean duration of alcohol dependence (5.57 ±3.44 years) in both the samples were similar.

**Correlates of neuropsychological dysfunctions in alcohol-dependence patients**

Overall, the findings partially support the conclusion reached by Parsons[89] that effects of alcoholism on the brain is influenced by a wide range of variables including the amount of alcohol consumed, the age of onset, and the duration of drinking; the patient’s age, level of education, gender, genetic background, and family history of alcoholism; and neuropsychiatric risk factors such as alcohol exposure before birth and general health status.
The majority of previous studies do not directly discuss the findings of our study that more academic achievement (in terms of years of education) has lesser neuropsychological dysfunctions, while more severity of alcohol dependence has more neuropsychological dysfunctions. The majority of them discuss the role of age at the time of assessment, age of onset of alcohol intake, duration of alcoholism, etc., with differing results. Goldman et al.[91] assessing abstinent alcoholics at 1 week and at 3 months after detoxification, found that age of assessment and severity of alcoholism (in terms of quantity and frequency of drinking) both were positively related to visuospatial impairment at initial assessment. However, they concluded that age was the critical variable in the failure to recover visuospatial dysfunctions at 3 months of abstinence. Similarly, Portnoff[92] found that early age of onset of alcohol intake, especially in teens, may have more neuropsychological dysfunctions than those who started drinking later, despite the similar total duration of alcohol intake. Narang et al. reported a positive correlation of cognitive impairment with the duration of alcohol use in alcoholic patients.[93]

The findings of our study are supported, to some extent, by the studies of two studies, which concluded that the duration of alcoholism has a small positive correlation with the severity of some neuropsychological dysfunctions, but this effect becomes statistically insignificant when the effects of patient age are controlled for.[94,95] In our study, no relationship of neuropsychological dysfunctions was found with either total duration of alcohol intake or duration of alcohol dependence in alcohol-dependent patients who were matched for age and education with normal controls. The study of Sullivan et al.[42] can be compared, to a greater extent, with our study because they found that age-corrected neuropsychological dysfunctions in domains of visuospatial and verbal and nonverbal working memory processes as well as gait and balance were not significantly correlated with age, time sober, or total lifetime alcohol consumption.

Although we could not find any correlation of age of onset of alcohol intake and neuropsychological dysfunctions in patients of alcohol dependence patients, a prospective study found that starting moderately heavy alcohol intake at an early age in both boys and girls had a negative impact on the neuropsychological performances at approximately 3 years of follow-up. The authors speculated that neurocognitive deficits may be linked to direct and indirect changes in neuro maturational course, with effects that would extend into adulthood.[96] This notion is further supported by the findings that neuropsychological dysfunctions like executive functions are affected early in alcohol dependence.[97]

**Comparison of neuropsychological dysfunctions in chronic schizophrenia patients and alcohol dependence patients**

**Domains of dysfunctions**

Out of 10 basic clinical scales of the AIIMS CNB, schizophrenia and alcohol-dependent patients differed significantly on the following: Tactile (100% vs. 86.7%, respectively) arithmetic (50% vs. 10%, respectively), memory (56.7% vs. 10%, respectively), and intellectual processes (46.7% vs. 0%, respectively) dysfunctions.

The study of Sullivan et al.[18] found that on comparison of patterns of content, contextual, and working memory functions, the schizophrenia group was significantly more impaired than the alcoholic group and supports our findings to a greater extent. Similarly, the findings of our study are supported by Allen et al.[98] who found cognitive dysfunction in alcohol dependence to be less severe than in schizophrenia on the Halstead-Reitan Neuropsychological Test. In contrast to our findings, Duffy and O’Carroll[144] found that the Alcoholic Korsakoff Syndrome group had far greater memory impairment than the schizophrenia group. The principal reason behind this contrasting finding is the selection of the sample. We emphasized the inclusion of only abstinent alcohol-dependent patients who had no evidence of either withdrawal or persistent alcohol induced amnesia (the Alcoholic Korsakoff Syndrome) or alcoholic dementia. Similarly, Nixon et al.[21] also reported that the neuropsychological performance of the alcoholic patients was not consistently better than the schizophrenia groups. The reason may be an emphasis on the selection of a sample of alcohol dependents who have a range of cognitive deficits in that study.

Thus our study supports the notion established by researchers that there are two different groups of alcohol dependents with alcohol-induced cognitive impairments:-the mildly–moderately impaired group and the severely impaired group, which have different underlying pathogenic processes and thus, should be studied separately.[98,99] The alcohol dependents of our study belong to the mildly–moderately impaired group and perform better than the chronic schizophrenia group in many neuropsychological areas.

**Limitations**

The sample size was relatively small and consisted of right-handed male participants only. This limits the generalization of the findings. The premorbid functioning of all three groups was not known in this study. This is important because neuropsychological dysfunctions may be more likely in those apparently healthy individuals who might later develop schizophrenia.
Being a cross-sectional study, it evaluated neuropsychological dysfunctions in alcohol dependents in their early abstinent period only and not in a late abstinent period where there are chances of many of such dysfunctions to recover.

CONCLUSIONS

The occurrence and severity of neuropsychological dysfunctions were highest in chronic schizophrenia patients, lowest in normal subjects, and intermediate in alcohol dependence patients. In comparison to normal subjects, chronic schizophrenia patients had significantly more dysfunctions in neuropsychological domains of motor, tactile, visual, receptive and expressive speech, reading, writing, arithmetic, memory, and intellectual processes. In comparison to normal subjects, alcohol dependence patients had significantly more dysfunctions in neuropsychological domains of motor, tactile, visual, receptive and expressive speech, reading, writing, arithmetic, and memory. In comparison to alcohol dependents, the chronic schizophrenia patients had more dysfunctions in neuropsychological domains such as tactile, arithmetic, memory, and intellectual processes. There were predominantly diffuse neuropsychological dysfunctions in both of these clinical groups. An inverse relationship was found between the neuropsychological dysfunctions and academic achievement in terms of years of education in both groups. Neuropsychological dysfunctions were directly related to the presence and severity of psychotic symptoms, particularly negative symptoms in chronic schizophrenia patients and the severity of alcohol dependence in alcohol-dependence patients.

Future directions
Future studies should involve larger samples with the involvement of participants of both genders.

The AIIMS CNB should also be used to assess changes in neuropsychological functions in such populations in longitudinal studies. The results of the AIIMS CNB should be correlated simultaneously with the various structural or functional neuroimaging techniques.

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Conflicts of interest
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