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RESEARCH ARTICLE

# COGNITIVE DEFICITS IN EARLY ONSET ALCOHOLISM

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**ABSTRACT**

**Background:** Alcoholism is a heterogeneous construct. It is classified predominantly into two types: Early onset alcoholism (alcohol dependence before the age of 25 years) and late onset alcoholism (alcohol dependence after the age of 25 years). Studies have reported that early onset alcoholism is more severe in nature as compared to the late onset alcoholism. Several studies have reported cognitive deficits in individuals with alcoholism. However, studies have not segregated early onset and late onset alcoholism, and other co-morbid conditions while assessing cognitive functions in individuals with alcoholism. Therefore, aim of this study was to examine the cognitive deficits in individuals with early onset alcoholism.

**Method:** This study is consisted a sample of 50 individuals with early onset alcoholism. Tools used in this study were socio-demographic and clinical data sheet to record the socio-demographic information (for e.g., age and education), as well as clinical information (for e.g., age of onset and age of dependence). Neuropsychological tests were administered to assess the cognitive functions. Tests included in this study were: Color Trail 1 & 2, Controlled Oral Word Association Test, Digit Span, Spatial Span, Ray's Auditory Verbal Learning Test and Complex Figure Test.

**Results:** Performance on the neuropsychological tests was compared with Indian norms. Results showed cognitive deficits in individuals with early onset alcoholism. Results also indicated that cognitive deficits may vary in individuals.

**Conclusion:** Individuals with early onset alcoholism demonstrated cognitive deficits. However, cognitive deficits may vary in individuals. Several individualistic and clinical factors may play a role in cognitive deficits produce by alcoholism. Study concludes that ameliorating cognitive deficits may enhance treatment efficacy.



## INTRODUCTION

Impairments in cognitive functions are a common consequence of alcoholism. Mild to moderate alcohol use can result in cognitive deficits impacting acquisition, storage, retrieval and information processing in individuals (1). Alcoholism is associated with a range of memory and executive functions deficits (2). The right hemisphere is more susceptible to the neurotoxic effects of alcohol, resulting in deficits on measures that are dependent on the functional integrity of the right hemisphere such as visuospatial processing (3).

Alcohol dependence produces a wide range of structural and functional abnormality in the frontal lobe (4). Several studies have demonstrated deficits on neuropsychological tests associated with deficits to the executive function (5-12). Further, studies have reported that cognitive functions worsen with the severity and duration of alcoholism (13, 14). Frontal lobe functions deficits are evident in chronic alcoholics. Study have demonstrated impairment in abstract thinking, concept formation, cognitive flexibility, set-shifting, sustained attention, information processing speed are evident in alcoholics (9), impairment in sustained and divided attention (15, 16), memory deficits in terms of encoding and retrieval (17).

Alcohol dependence is classified predominantly into two categories. This classification is based on family history, age of onset, clinical symptoms, and personality traits. The purpose of this classification was to define the subtypes of alcoholics, severity and increased risk for developing the disorder (18-20).

Cloninger, Bohman (21), classified alcoholism into two types: (i) milieu-limited alcoholism and (ii) male- limited alcoholism. The male- limited type was found to be highly heritable among male offspring of male biological parents with history of treatment for alcohol abuse and was associated with externalizing spectrum disorder and anti-social problems. The milieu – limited or environment related type of alcoholism

associated with recurrent of alcohol abuse without externalizing spectrum disorders or anti-social problems or positive history of alcoholism in the biological parents. These subtypes later named as Type I and Type II (22). Clinical characteristics of Type I alcoholism are anxious personality traits, rapid development of tolerance and dependence on the anti-anxiety effects of alcohol. This leads to loss of control, difficulty in terminating once initiate, guilt feelings, and liver complications. It occurs in both sexes, has a later age of onset (after 25 years of age), less severe and associated with low degree of novelty seeking and high degree of harm avoidance. This subtype has a better response to treatment. Whereas, a person with type II alcoholism is characterized by early onset (before 25 years of age), having antisocial personality traits and persistent seeking of alcohol for its euphoric effects, spontaneous alcohol seeking behavior and fighting, less feeling of guilt, low harm avoidance and high thrill seeking behaviors. This subtype of alcoholism has more severe course, more alcohol related social problems and has a poor response to treatment.

Similarly, Babor and colleagues (18) also classified alcoholism into two types- Type A and Type B alcoholism. Type A alcoholism are characterized by later age onset, fewer childhood risk factors, less severe dependence, fewer alcohol related problems and less psychopathologic dysfunctions. The second group which is designated as Type B was characterized by childhood risk factors, alcoholism in family, early onset of alcohol drinking, greater severity of dependence, poly-substance abuse and more psychopathologies. These two types also reflect differences in prognostic and treatment outcome.
There are paucity of research in the area of early onset alcoholism and cognitive deficits. Hence, the present study aimed to examine the cognitive deficits in individuals with early onset alcoholism.

## METHOD

A sample of 50 individuals with early onset alcohol dependence was recruited from the centre of addiction medicine, National Institute of Mental Health and Neurosciences (NIMHANS), Bengaluru. They were screened for the alcohol dependence as per ICD-10 research diagnostic criteria. All the participants were in the age range between 18 to 45 years, right handedness, English, Hindi or Kannada speaking with the minimum education of 8$^{th}$ standard. Individuals excluded for the participation in this study, if they met the criteria for**:** 1. Presence of substance dependence other than tobacco 2. Any major psychiatric disorders excluding externalizing spectrum disorders in view of etiological factor and high co-morbidity with early onset alcohol dependence. 3. Co-morbid major medical or neurological disorders 4. Score on Hindi Mental State Examination (HMSE) less than 25 and 5. Mental retardation from clinical interview/observation.

***Tools:*** Tools used in this study were: Socio demographic and Clinical data sheet to record the socio-demographic information (for e.g., age and education) as well as clinical information such as age of onset and age of dependence. Edinburgh Handedness Inventory (23) was used to assess the handedness. Only right handed subjects were recruited for this study. Mini-international Neuropsychiatry Interview (M.I.N.I.): Screen form & M.I.N.I. Plus (24) was used to screen the other major psychiatric disorders. Short Alcohol Dependence Data Questionnaire (SADDQ) (25) was used to assess the severity of alcohol dependence. Hindi Mental State Examination (HMSE) (26) was used to exclude the patients with severe cognitive and memory impairment. Those who scored less than 24 on this scale were excluded from this study.

The neuropsychological tests included in this study were: Color Trails Test 1 and 2 (27): The Color trails test has two parts. Part 1 assesses speed for attention, simple sequencing, focused attention, perceptual tracking and visual search, while part 2 assesses mental flexibility in addition to the above mentioned functions. Controlled Oral Word Association (COWA) Test (28): This test evaluates the spontaneous production of words beginning with a given letter within a limited amount of time. Spatial Span (29) has two condition: Forward and Backward. For spatial span forward, the examiner taps the cubes in a given sequence and the subject has to tap it in same sequence while in backward the subject is required to tap in reverse order. The composite score of forward and backward used to provide the index of visuospatial working memory. Digit span (29) has two condition: Forward and Backward. For digit span forward, the examiner reads a sequence of digits and subject has to recall it in the same order while in the backward subject is required to recall the sequence of digits in reverse order. The composite score of forward and backward used to provide the index of verbal working memory. Ray's Auditory Verbal Learning Test (RAVLT) (30): This test is originally developed by Rey in 1958 (as cited in Spreen & Strauss, 1998). It was adapted to suit Indian conditions (31). This test assesses the learning of verbal items (words), immediate and delayed memory as well as recognition memory. Complex Figure Test (CFT) (32): This test assesses visuospatial construction ability and visual learning and memory as well as planning and organizational skills (28).

***Procedure:*** Subjects with early onset alcohol dependence were recruited for study from centre of addiction medicine, NIMHANS, Bengaluru. The mentioned inclusion and exclusion criteria were followed in the process of selection of subjects. Written informed consent was obtained from each participant. Ethical clearance was obtained from Institute ethics committee. Neuropsychological tests were administered on each participant after the 4 days of detoxification for alcohol. Adequate rest pause was given between the tests to reduce the effect of fatigue.

***Statistical analysis:*** The data was analyzed using Statistical Package for Social Sciences-version 22 (SPSS-22) for windows. The normative data for comparison were taken from NIMHANS Neuropsychology battery (31) and Wechsler Memory Scale, 3$^{rd}$ edition, India (WMS-III, India) (33).

## RESULTS

The Subjects were categorized into four groups for comparison with normative data of Indian population based on age and education. These groups are: (1) Young adults with school education. The age range of subjects was 16-30 years in this group. They were school educated (i.e., educated till or below 10 standards). (2) Young adults with college education. In this group, age range of subjects was 16 to 30 years and they were college educated (i.e., educated above the 10 standards). (3) Middle aged adults with school education. In this group, subjects were in the age range of 31 to 50 years with school education (i.e., educated till or below 10 standards). (4) Middle aged adults with college education. In this group, subjects were in the age range of 31 to 50 years with college education (i.e., educated above the 10 standards) (Table 1).

**Table 1** Number of subjects in each group

| Groups | Number of subjects |
|---|---|
| Group 1: Young adults with school education | 8 |
| Group 2: Young adults with college education | 7 |
| Group 3: Middle aged adults with school education | 24 |
| Group 4: Middle aged adults with college education | 11 |

***Clinical characteristics of the groups:*** The age of onset of alcohol use was reported from 17 years to 20 years among the groups (Table 2). Similarly, groups also had variation for of age of dependence, total years of alcohol use and total years of alcohol dependence (Table 2).

**Table 2** Clinical characteristics of the groups

| **Group 1: Young adults with school education (N=8)** | |
|---|---|
| **Variables** | **Mean ± SD** |
| Age of onset | 17.13 ± 3.04 |
| Age of dependence | 22.38 ± 2.67 |
| Total years of alcohol use | 11.25 ± 2.71 |
| Total years of alcohol dependence | 6.13 ± 3.00 |
| SADDQ | 29.63 ± 13.14 (High dependence) |
| **Group 2: Young adults with college education (N=7)** | |
| Age of onset | 20.14 ± 2.48 |
| Age of dependence | 24.00 ± 1.63 |
| Total years of alcohol use | 7.57 ± 2.64 |
| Total years of alcohol dependence | 3.86 ± 1.57 |
| SADDQ | 22.43 ± 10.41 (High dependence) |
| **Group 3: Middle aged adults with school education (N=24)** | |
| Age of onset | 18.79 ± 2.69 |
| Age of dependence | 23.79 ± 3.00 |
| Total years of alcohol use | 17.75 ± 4.66 |
| Total years of alcohol dependence | 12.83 ± 4.51 |
| SADDQ | 22.71 ± 7.78 (High dependence) |
| **Group 4: Middle aged adults with college education (N=11)** | |
| Age of onset | 19.82 ± 2.71 |
| Age of dependence | 24.73 ± 1.35 |
| Total years of alcohol use | 16.82 ± 7.00 |
| Total years of alcohol dependence | 11.82 ± 5.23 |
| SADDQ | 20.45 ± 8.19 (High dependence) |

SADDQ= Severity of Alcohol Dependence Data Questionnaire

Result showed that individuals with alcoholism have cognitive deficits in multiple domains including focused attention and information processing, mental flexibility, working memory in both modality (i.e., auditory and visuospatial), learning and memory, recognition ability, visuoconstruction ability and visual memory (Table 3-6). However, result also indicates that some of the cognitive functions were adequate in each group (Table 3-6). This means that cognitive deficits produced by early onset alcoholism may vary in individuals.

**Table 3** shows the performance of group 1 (age between 16-30 years with school education)

| Tests | Functions | Mean of obtained score | Percentile score | Impression |
|---|---|---|---|---|
| Color Trail-1 (Time) | Focused attention and information processing | 96.63 | Below 18th | **Impaired** |
| Color Trail-2 (Time) | Mental flexibility | 204.38 | 18th | Adequate |
| COWA | Verbal fluency | 8.00 | 50th -60th | Adequate |
| Digit span | Verbal working memory | 11.63 | 30th -40th | Adequate |
| Spatial Span | Visuospatial working memory | 13.50 | 25th -30th | Adequate |
| CFT-Copy | Visuoconstruction ability | 33.88 | 25th -30th | Adequate |
| CFT-IR | Visual immediate memory | 13.13 | 15th | Impaired |
| CFT-DR | Visual delayed memory | 12.63 | Below 15th | Impaired |
| AVLT-T1 | Learning | 5.13 | 10th -15th | Impaired |
| AVLT-T2 | | 7.25 | Below 5th | Impaired |
| AVLT-T3 | | 9.13 | Below 5th | Impaired |
| AVLT-T4 | | 9.25 | Below 5th | Impaired |
| AVLT-T5 | | 10.13 | Below 5th | Impaired |
| AVLT- Total | | 40.88 | Below 5th | Impaired |
| AVLT-IR | Verbal immediate memory | 7.25 | Below 5th | Impaired |
| AVLT-DR | Verbal delayed memory | 7.00 | Below 5th | Impaired |
| AVLT-Hits | Recognition ability | 12.75 | Below 10th | Impaired |
| AVLT-Miss | | 2.25 | 14th | Impaired |
| AVLT-FA | | 1.13 | 34th | Adequate |

COWA= Controlled Oral Word Association Test, CFT= Complex Figure Test, IR= Immediate recall, DR= Delayed recall, AVLT= Auditory Verbal Learning Test, T1= Trial no. 1; FA= False alarm

**Table 4** shows the performance of group 2 (age between 16-30 years with college education)

| Tests | Functions | Mean of obtained score | Percentile score | Impression |
|---|---|---|---|---|
| Color Trail-1 (Time) | Focused attention and information processing | 72.14 | 24th | Adequate |
| Color Trail-2 (Time) | Mental flexibility | 148.00 | Below 14th | **Impaired** |
| COWA | Verbal fluency | 10.95 | 40th -50th | Adequate |
| Digit span | Verbal working memory | 12.29 | Below 15th | **Impaired** |
| Spatial Span | Visuospatial working memory | 13.71 | Below 15th | **Impaired** |
| CFT-Copy | Visuoconstruction ability | 35.00 | 10th | **Impaired** |
| CFT-IR | Visual immediate memory | 19.21 | Below 15th | **Impaired** |
| CFT-DR | Visual delayed memory | 18.14 | Below 10th | **Impaired** |
| AVLT-T1 | Learning | 5.43 | 20th -25th | Adequate |
| AVLT-T2 | | 9.29 | 20th -25th | Adequate |
| AVLT-T3 | | 10.86 | 20th -25th | Adequate |
| AVLT-T4 | | 11.71 | 25th -30th | Adequate |
| AVLT-T5 | | 12.71 | 25th -30th | Adequate |
| AVLT-Total | | 50.00 | 25th | Adequate |
| AVLT-IR | Verbal immediate memory | 11.14 | 25th | Adequate |
| AVLT-DR | Verbal delayed memory | 9.86 | Below 15th | **Impaired** |
| AVLT-Hits | Recognition ability | 13.43 | Below 15th | **Impaired** |
| AVLT-Miss | | 1.57 | Below 26th | Adequate |
| AVLT-FA | | 0.86 | 26th | Adequate |

**Table 5** shows the performance of group 3 (age between 31-50 years with school education)

| Tests | Functions | Mean of obtained score | Percentile score | Impression |
|---|---|---|---|---|
| Color Trail-1 (Time) | Focused attention and information processing | 88.08 | 29th | Adequate |
| Color Trail-2 (Time) | Mental flexibility | 211.00 | Below 17th | Impaired |
| COWA | Verbal fluency | 8.01 | 50th | Adequate |
| Digit span | Verbal working memory | 10.42 | 40th -50th | Adequate |
| Spatial Span | Visuospatial working memory | 12.54 | 40th -50th | Adequate |
| CFT-Copy | Visuoconstruction ability | 34.58 | 40th -50th | Adequate |
| CFT-IR | Visual immediate memory | 11.31 | Below 5th | Impaired |
| CFT-DR | Visual delayed memory | 9.65 | Below 5th | Impaired |
| AVLT-T1 | Learning | 5.33 | 20th | Adequate |
| AVLT-T2 | | 8.04 | 25th -30th | Adequate |
| AVLT-T3 | | 9.29 | 20th | Adequate |
| AVLT-T4 | | 10.04 | 15-20th | Adequate |
| AVLT-T5 | | 10.75 | 20th -25th | Adequate |
| AVLT- Total | | 43.46 | 15th | Impaired |
| AVLT-IR | Verbal immediate memory | 8.38 | Below 15th | Impaired |
| AVLT-DR | Verbal delayed memory | 7.92 | Below 15th | Impaired |
| AVLT-Hits | Recognition ability | 13.29 | 20th | Adequate |
| AVLT-Miss | | 1.67 | 23th | Adequate |
| AVLT-FA | | 1.13 | 32th | Adequate |

**Table 6** shows the performance of group 4 (age between 31-50 years with college education)

| Tests | Functions | Mean of obtained score | Percentile score | Impression |
|---|---|---|---|---|
| Color Trail-1 (Time) | Focused attention and information processing | 98.36 | 15th | Impaired |
| Color Trail-2 (Time) | Mental flexibility | 192.27 | 12th | Impaired |
| COWA | Verbal fluency | 11.15 | 40th | Adequate |
| Digit span | Verbal working memory | 12.64 | 20th -25th | Adequate |
| Spatial Span | Visuospatial working memory | 14.91 | 50th | Adequate |
| CFT-Copy | Visuoconstruction ability | 33.73 | 15-30th | Adequate |
| CFT-IR | Visual immediate memory | 14.73 | 10th | Impaired |
| CFT-DR | Visual delayed memory | 13.77 | Below 15th | Impaired |
| AVLT-T1 | Learning | 6.18 | 30th | Adequate |
| AVLT-T2 | | 9.00 | 10th | Impaired |
| AVLT-T3 | | 10.91 | 30th | Adequate |
| AVLT-T4 | | 11.36 | 25th | Adequate |
| AVLT-T5 | | 12.09 | 40th | Adequate |
| AVLT-Total | | 49.55 | 25th | Adequate |
| AVLT-IR | Verbal immediate memory | 10.45 | 25th -30th | Adequate |
| AVLT-DR | Verbal delayed memory | 9.73 | 25th -30th | Adequate |
| AVLT-Hits | Recognition ability | 14.55 | 25th -30th | Adequate |
| AVLT-Miss | | 0.45 | Above 28th | Adequate |
| AVLT-FA | | 0.73 | Above 22th | Adequate |

## DISCUSSION

Aim of the present study was to examine the cognitive deficits in individuals with early onset alcoholism. For this, 50 subjects with early onset alcoholism were recruited from the centre of addiction medicine, NIMHANS, Bengaluru. All the subjects were male. They were right handedness as assessed by Edinburgh Handedness Inventory. Neuropsychological tests administered on them and their performance was compared with the normative data of Indian population.

Table 3-6, shows that individuals with alcoholism display cognitive deficits in multiple domains including focused attention and information processing, mental flexibility, working memory in both modality (i.e., auditory and visuospatial), learning and memory, recognition ability, visuoconstruction ability and visual memory. These findings are in accordance with several other studies that have demonstrated deficits in sustained and divided attention (15, 16); phonemic fluency and visual working memory (34); learning and memory (35); visuospatial and visual memory deficits (36). Several studies have demonstrated deficits on neuropsychological tests associated with deficits to the executive function in alcoholics (5-12).

However, not all alcoholics demonstrated cognitive deficits. Cognitive deficits may depend on several individualistic factors as well as factors related to alcohol use and dependence. In individualistic factors age and education, health status, pre-morbid functioning are the important factors while age of onset, age of dependence, years of alcohol use and dependence, relapses and other co-morbid disorders are the important factors related to cognitive deficits in alcoholics. Age and education may have impact on cognitive functions. Alcohol use may impact more hazardously on the cognitive functions in older adults because of aging related changes in brain. Studies have reported cognitive deficits in healthy normal older adults (37, 38). On the other hand, studies have documented that alcohol use at earlier age is a strong predictor of alcohol related problem in later life (39-43). This can be understood that cognitive development occurs through the neuronal maturation till the late adulthood (44). Similarly, education can also have impact on cognitive functions. Studies have reported association of education and cognitive function (37, 45, 46).

Several studies have demonstrated association between cognitive deficits and factors related to alcohol use and dependence. Al-Zahrani and Elsayed (47), reported more cognitive deficits in individuals with longer duration of dependence and multiple hospital re-admissions compared to the individuals with shorter duration of dependence and less re-admission.

Smeraldi, Movalli (48), have reported variation in cognitive deficits produce by alcoholism. They reported that 45.7% individuals with alcoholism demonstrated generalized declined in cognitive functions. While 26.1% shown deficits in verbal memory; 32.6% demonstrated deficits in working memory; 50.0% demonstrated deficits in psychomotor speed and coordination; 30.4% demonstrated deficits in verbal fluency; 58.7% demonstrated deficits in selective attention; 13.0% demonstrated deficits in planning; 41.3% demonstrated deficits in executive functions; 56.5% demonstrated deficits in sustained attention. Several other researchers have also reported variability in cognitive deficits in individuals with

alcoholism. Ihara, Berrios (49), examined cognitive functions in individuals with alcoholism and reported that some of the cognitive functions were intact in individuals with alcoholism while on some other cognitive functions they demonstrated deficits.

Cognitive deficits leads poor prognostic outcome and may impact detrimentally (50, 51). Most common treatment methods used generally in treating individuals with alcoholism are pharmacological treatments, behavioral treatments, motivation interviewing (50). Most of the treatment methods for alcoholism do not consider the detrimental impact of cognitive deficits (50, 51). Intervention studies using cognitive remediation have shown its effectiveness in ameliorating cognitive deficits in various clinical conditions (52, 53). Therefore, future studies should examine the effectiveness of cognitive remediation along with other treatments strategies in treating individuals with early onset alcoholism for better treatment efficacy.

## CONCLUSION

Alcoholism may produce a wide range of cognitive deficits. These deficits may depend on several individualistic factors as well as factors related to alcohol use and dependence. The present study demonstrated cognitive deficits in individuals with alcoholism. However, a major limitation of this study is small sample size. Future study should include a large sample size to document the cognitive functions on neuropsychological tests. Future study should also include tasks related to other executive functions such as decision making, planning and set-shifting etc. This study concludes that treatment for alcoholism should incorporate cognitive remediation program to ameliorate cognitive deficits for better treatment efficacy.

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