# Associating neuropsychological deficits with decreased gray and white matter density in alcohol dependents: a voxel based morphometric analysis using DARTEL

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**Target audience:** Researchers working in the field of drug abuse and imaging.

**Introduction:** Chronic alcohol consumption has been consistently associated with severe brain atrophy (primarily in fronto-parietal brain regions) and mild to severe neuropsychological impairments.[1]Although there is a substantial literature on alcohol-associated brain impairments of visuospatial abilities, very few studies aimed at associating the altered brain morphometry with these psychological deficits in alcohol dependents.[2] The present study aimed at looking for an association between the regional gray and white matter volume loss and deficits in visuospatial abilities and duration of alcohol consumption in alcohol dependents. To that end, we used a whole-brain, voxel-based morphometry (VBM) approach using DARTEL (Diffeomorphic Anatomic Registration Through Exponentiated Lie algebra algorithm) and selective neuropsychological tests of PGIBBD (PGI-Battery of Brain Dysfunction) (an Indian version of Wechsler adult intelligence scale) that assesses visuospatial information processing functions.[3]

**Material and methods:** High resolution structural MR images were taken in normal healthy controls (n=20) and alcohol dependent subjects (with less than ten years of alcoholism (n=18) and more than ten years of alcoholism (n=18)). Some of the alcohol dependent subjects were very rarely occasional smokers. All subjects were age,education and handedness matched. The subjects were abstained from alcohol at the time of study with an abstinent period of more than a week. The analysis was carried out using SPM8 software on MATLAB 7.6.0 platform. The PGIBBD subtests were conducted as neuropsychological evaluations on all subjects on the day of examination. The study was carried out using 3T whole body MR system (Magnetom Skyra, Siemens, Germany) with a 32 channel head coil.

**Results and discussion:** VBM results showed a significant reduction in both gray and white matter volumes in alcohol dependents as compared to controls. Gray matter volume loss was observed bilaterally in fronto-parietal brain regions namely, putamen ,frontal gyrus(Inferior, middle and superior), postcentral gyrus , superior parietal lobule and inferior temporal gyrus[Fig.1] whereas significant white matter volume loss was observed primarily in right hemisphere regions namely, inferior parietal lobule, postcentral gyrus, frontal gyrus (Inferior and middle),temporal gyrus(Inferior and Middle) [Fig.2].No areas of white matter loss were observed in left hemisphere. With growing years of alcohol dependence, brain shrinkage was most prominent in parietal lobe .There was a significant deficit in PGIBBD DRS (Dysfunction Rating Scores) in alcohol dependents (Table 1). The visuospatial skills are primarily ascribed to parietal lobe. Although, the present study has shown volume loss in frontoparietal brain regions but with increase in duration of alcohol consumption, parietal lobe is most severely affected and so are the visuospatial skills in alcohol dependents.[4]So, deficits in visuospatial skills and loss in gray and white matter in parietal lobe might reflect an association. As per literature citation, verbal skills (attributed to left hemisphere) are relatively spared in alcoholics which is very well correlated with no white matter volume loss observed in left hemisphere. These findings suggests that regional gray and white matter volume loss in parietal brain regions might be responsible, at least in part, for impaired visuospatial skills in alcohol dependents.

**Conclusion:** The present study leads us to conclude that chronic alcoholism damages both gray and white matter of fronto-parietal brain regions, which gradually extends over parietal lobe with growing years of alcoholism, might contribute to the deficits in visuospatial processing observed in alcohol dependents.

**References**

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| Dysfunction Rating Score assessed by PGIBBD(DRS) | | |
|---|---|---|
| Subtest | Alcohol dependents (Mean ±S.D.) | Controls (Mean ±S.D.) |
| Visual perception | 1.611 ±1.613 | 0 |
| Visual retention | 1.833 ±1.504 | 0.2 ±.77 |
| Visual recognition | 1.277 ±1.263 | 0.29 ±.84 |
| Spatial processing | 1 ±1.309 | 0.17±.22 |

Table 1: DRS scores of alcohol dependents and controls (p value≤0.05)

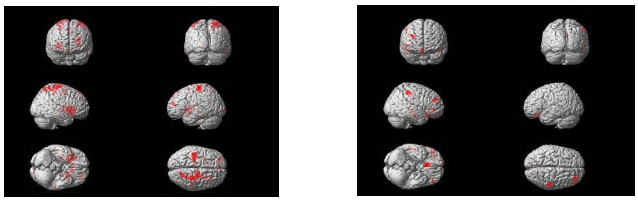

Fig. 3D rendered view of gray (a) and white (b) matter loss in alcoholic>controls