Randomness of functional network connectivity in alcohol use disorder

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Background: In this work we focus on the level to which patterns in resting state functional network connectivity (FNC) matrices are random. The randomness measure compares the singular values (SVs) of FNC matrices against SVs of random matrices. We hypothesize that such an approach will detect differences in the brain of subjects with alcohol use disorder.

Methods: Functional magnetic resonance imaging data were collected from twenty six subjects (mean age 30 years with 11 females) who scored 9 or more in the alcohol use disorder identification test. In addition, twenty six age (up to 3 years) and sex matched controls were included. Group independent component analysis was used to identify thirty nine resting state networks grouped in nine subgroups. For each subject we calculated the SVs of the corresponding FNC matrix. We estimated mean and standard deviation of each SV from Gaussian random matrices of the same size and variance. Then we calculated a Z-score, based on estimated mean and standard deviation, for each SV in the FNC matrix. The randomness measure L was taken as the root mean square of the Z-scores. Larger values of L indicate less likeness to a random matrix.

Results: An unpaired t-test showed significant differences on the L measure for the whole FNC between the two groups. We repeated the test for each of the 45 possible submatrices in the FNC. Figure 1 show the FNC submatrices with significant (false discovery rate corrected p < 0.05) group differences: SBC (subcortical)-ECN (executive control network), SBC-SEN (sensorimotor), SEN-SEN, SEN-DMN (default mode network) and VIS (visual)-PRE (precuneus). In all group tests drinkers had significantly smaller L-values indicating FNCs more similar to a random matrix than controls FNCs.

Conclusions: Randomness in brain’s functional connectivity may be assessed by comparison of SVs. Drinkers suffering alcohol use disorder may present FNC closer to a random matrix than healthy controls. Increased randomness may be an indication of functional connectivity dysfunction in the brain of drinkers.