Association of structural brain imaging markers with alcoholism incorporating structural connectivity information: a regularized statistical approach

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Abstract: Brain imaging studies collect multiple imaging data types, but most analyses are done for each modality separately. Statistical methods that simultaneously utilize and combine multiple data types can instead provide a more holistic view of brain function. Here we model associations between alcohol abuse phenotypes and imaging data while incorporating prior scientific knowledge. Specifically, we utilize cortical thickness and integrated rectified mean curvature measures obtained by FreeSurfer software [1] to predict the alcoholism-related phenotypes while incorporating prior information from the structural connectivity between cortical regions. The sample consisted of 148 young (21-35 years) social-to-heavy drinking male subjects from several alcoholism risk studies [2,3,4]. Structural connectivity model [5] was used to estimate the density of connections between 66 cortical regions based on Desikan-Killiany atlas [6]. We employed a functional linear model with a penalty operator to quantify the relative contributions of imaging markers obtained from high resolution structural MRI (cortical thickness and curvature) as predictors of drinking frequency and risk-relevant personality traits, while co-varying for age. Model parameters were estimated by a unified approach directly incorporating structural connectivity information into the estimation by exploiting the joint eigenproperties of the predictors and the penalty operator [7]. We found that the best predictive imaging markers of the Alcohol Use Disorders Identification Test (AUDIT) score were the average thickness of left frontal pole (-), right transverse temporal gyrus (+), left inferior parietal lobule (+), right supramarginal gyrus (-), right rostral middle frontal gyrus (+), right precentral gyrus (+), left superior parietal lobule (-), left lateral orbitofrontal cortex (+), left rostral middle frontal gyrus (+), left postcentral gyrus (+) and left supramarginal gyrus (-), where (+) denotes positive and (-) negative association. In summary, the use of structural connectivity information allowed the incorporation of different modalities in associating cortical measures and alcoholism risk.

References:

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