Widespread associations between grey matter structure and the human phenome

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Résumé

The recent availability of large-scale neuroimaging cohorts (here the UK Biobank [UKB] and the Human Connectome Project [HCP]) facilitates deeper characterisation of the relationship between phenotypic and brain architecture variation in humans. We tested the association (previously coined morphometricity) between 654,386 vertex-wise measures of cortical and subcortical morphology (from T1w and T2w MRI images) and a large number of behavioural, cognitive, psychiatric and lifestyle phenotypes. We found significant morphometricity for 58 out of 167 UKB phenotypes spanning substance use, blood assay results, education or income level, diet, depression, being a twin as well as cognition domains (UKB discovery sample: N=9,888). Twenty-three of the 58 associations replicated (UKB replication sample: N=4,561; HCP, N=1,110). We extended the morphometricity framework to the bivariate case (grey-matter correlations) which revealed that differences in body size (height, weight, BMI, waist and hip circumference, body fat percentage) could account for a substantial proportion of the association (confirmed using a conditional analysis). This provides possible insight into previous MRI case-control results for psychiatric disorders where case status is associated with body mass index. Using the same model formulation, we achieved out of sample prediction from grey-matter structure for all associated phenotypes, allowing, for example, the study of phenotypes not collected in the HCP. Finally, we demonstrated additional new applications of our approach (i) Region Of Interest (ROI) analysis that retain the vertex-wise complexity; (ii) comparison of the information retained by different MRI processing options.

Mots-Clés: structural MRI, mixed models, UK Biobank, association, prediction, morphometricity

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