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CEREBRAL CORTEX

Multi-modal mapping

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As a step towards understanding the workings of the human cerebral cortex, various cortical maps, or parcellations, have been produced that subdivide this structure, mostly according to function, microstructure, connectivity or topography. In a new study, Glasser *et al.* used MRI images from the Human Connectome Project (HCP) and a semi-automated neuroanatomical approach to generate a multi-modal parcellation of the human cerebral cortex.

The authors used multiple imaging data sets from the HCP for 449 individuals; these data sets included images from task functional MRI (fMRI) to reveal cortical function, images from resting-state fMRI to determine functional connectivity and, for some areas, cortical topography (for example, maps of visual space in the brain), and T1- and T2-weighted structural MRI data to measure cortical thickness and relative myelin content (measures of architecture). For each data set for each individual, the authors performed an areal-feature-based cortical surface registration. These maps were then averaged to create group maps for each measure (for example, myelin content) for two groups of 210 individuals.

For one of these groups — the 210 parcellation (210P) group — the authors used a semi-automated neuroanatomical approach to determine the boundaries between different cortical areas based on the group-averaged maps. A key criterion to delineate a boundary was that transitions in at least two areal properties (function, architecture, connectivity or topography) should be observed from one area to the next. During this process, two neuroanatomists assessed the candidate borders to exclude artefacts and related the proposed borders to previously defined neuroanatomical regions. Using this approach, the authors generated a parcellation of 180 cortical areas per hemisphere, comprising 83 areas that had previously been defined and 97 newly defined areas. The authors initially validated their parcellation through an analysis using group-averaged data sets from the other group of 210 individuals (the 210 validation (210V) group); statistical testing showed that the areas were indeed different from their neighbours.

The authors recognized that this semi-automated approach would not be suitable to generate cortical parcellations for individuals. Therefore, they developed an areal classifier, which was based on a machine-learning classifier that had previously been used to determine resting-state functional networks in individuals. They trained the classifier with the individual data sets from the 210P group and from a group of additional 29 people who were not included in the 210P or 210V group, so that it could learn the multi-modal 'areal fingerprint' of each cortical area in the parcellation, and found that it had a 96.6% areal detection rate when it was applied to individual data sets from the 210V group.

According to the authors, this parcellation and the related tools will assist future studies of the human cerebral cortex by providing greater neuroanatomical accuracy.

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