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Intracortical microstructural asymmetry in the human cortex: laminar differentiation, organization, heritability, and relevance to language function and psychopathological traits

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The cerebral cortex shows subtle left-right morphological asymmetry supporting hemispheric specialization of functional processes including attention and language, which is also associated with neuropsychiatric conditions. However, previous studies consider gray matter as a morphological feature rather than a laminar structure to study asymmetry. Here, we leveraged intensity profiles from ultra-high resolution post-mortem histological data and in vivo magnetic resonance imaging to describe the layer-related intracortical microstructural asymmetry in the human cortex. We observed the left-right asymmetry wave of intracortical microstructure along the layers in post-mortem histological data. Extending our model to in vivo MRI, we observed that default mode, ventral multimodal, and somatomotor networks transfer the asymmetry directions along the intracortical depth. This pattern was observed to be more heritable in middle-depth surfaces, indicating cellular lateralization may share more genetic information to guide brain functions than molecular lateralization. Furthermore, in terms of the system-level laminar organization, inverted U-shape lateralization was observed along the sensory-fugal axis, which was rarely shaped by genetic factors. Last, using supervised machine learning, we observed microstructural asymmetry features in cingulate and prefrontal cortices are more often selected to predict language functions and psychopathological traits. In sum, using a multilevel model, we find laminar and organization differentiation along the sensory-fugal axis in the microstructural asymmetry in the human cortex and its potential application to psychiatric conditions.

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