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Cytoarchitectonic Maps of five newly identified Areas in the human Dorsolateral Prefrontal Cortex

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The dorsolateral prefrontal cortex (DLPFC) is involved in 'higher-order'cognitive control and executive functions, including working memory, value encoding, attention, and decision making in the control of behavior. Pathological variations of the DLPFC are key findings in various disorders, such as vascular dementia, depression, schizophrenia, and obsessive-compulsive disorders. Previous research, has resulted in different cortical maps concerning the number and extent of DLPFC-areas. Here we aim to establish microstructural, cytoarchitectural maps of the DLPFC including the region of Brodmann area 9 and 46. Considering the large size of the DLPFC, we focused on the superior frontal gyrus and caudal aspects of the medial frontal gyrus.
Cell body-stained histological sections of ten human brains including the BigBrain (five male, five female; age range from 30 to 86 years) from the Body Donor Program of the Department of Anatomy of the University of Düsseldorf were analyzed (Amunts et al., 2020). Using observer-independent mapping, five new areas (i.e., SFG2, SFG3, SFG4, MFG4 and MFG5) were identified that occupy the anterior superior frontal gyrus (SFG2 –SFG4) and middle frontal gyrus (MFG4, MFG5). Neighboring areas of the investigated region of interest are the frontal pole (rostral; Bludau et al. 2014), the anterior DLPFC-areas (lateral; SFS1, SFS2, MFG1, and MFG2, Bruno et al., 2022), Broca's region (ventral, area 44; Amunts, 1999), and the premotor and prefrontal cortex (caudal, area 6; Sigl et al., 2016; and 8). Inter-area differences were studied using gray-level index (GLI-)profiles, reflecting alterations in the volume fraction of cell bodies from layer II to the cortex-white matter border. We found that the outer granule cell layer II is narrow and densely packed in all areas except SFG2 (broad and densely packed). Layer III can be divided into two sublayers in SFG2, whereas the other areas show a three-sublayered layer III with varying densely packed medium-sized pyramidal cells. SFG-areas are more likely to have a radiating cell gradient, while MFG-areas demonstrate rather diffuse transitions among the sublayers IIIa –IIIc. Layer IV is a distinct and prominent granule cell layer in all studied areas except SFG3 (diffuse). Layer V is two-layered in SFG3 with a cell-poor layer Vb, while the remaining areas displayed a single-layered layer V with medium sized pyramidal cells. Layer VI is prominent and densely packed in all investigated areas.
The areas were labeled in images of histological sections over their full extent, and will serve as the basis for 3D reconstruction and subsequent computation of cytoarchitectonic probability maps.
The maps will be available publicly and accessible through the EBRAINS Knowledge Graph and the Human Brain Project's interactive atlas viewer (https://interactive-viewer.apps.hbp.eu/).

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