





Human Brain Project

Cytoarchitectonic mapping of the human olfactory tubercle and terminal islands

Joko Poleksić









Basal forebrain





Dissociated Representations of Irritation and Valence in Human Primary Olfactory Cortex

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Mapping the Microstructure and Striae of the Human Olfactory Tract with Diffusion MRI

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Characterizing functional pathways of the human olfactory system

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- Olfactory dysfunction (hyposmia) is an early clinical sign of AD and PD
- Post-mortem studies confirmed the presence of pathological changes in the olfactory tubercle

Terminal islands

- Clusters of small cells scattered in the basal forebrain
- Granular (γ_1) and parvicellular ($\gamma_{2,} \gamma_3$) islands
- Imatture cells with potential for postnatal development?
- Pathophysiology of schizophrenia?







Great Terminal Island (GTI)

BigBrain: An Ultrahigh-Resolution 3D Human Brain Model

Katrin Amunts,^{1,2,3,4}* Claude Lepage,⁵ Louis Borgeat,⁶ Hartmut Mohlberg,^{1,2} Timo Dickscheid,^{1,2} Marc-Étienne Rousseau,⁵ Sebastian Bludau,^{1,2} Pierre-Louis Bazin,⁷ Lindsay B. Lewis,⁵ Ana-Maria Oros-Peusquens,^{1,2} Nadim J. Shah,^{1,2} Thomas Lippert,⁸ Karl Zilles,^{1,2,3,4} Alan C. Evans⁵





7404 coronal sections stained for cell bodies, digitized (20μm isotropic) and 3D reconstructed



cytoarchitecture



functional neuroimaging

Integration of multimodal data



receptor/neurotransmiter distribution



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Aim

- To determine the localization of olfactory tubercle and terminal islands in stereotaxic space and intersubject variability based on cytoarchitectonic probability maps
- 3D reconstruction of the Great Terminal Island (GTI) in the BigBrain, to define its anatomical features

Histological processing and Cytoarchitectonic probability maps

- 10 human post mortem brain (5 male, 5 female)
- Sectioning, staining and digitization
- Cytoarchitectonic mapping, spatial normalization and transfer to the reference space
- Superimposition of the individual maps and probability maps calculation

Brain Collection, Forschungszentrum Juelich, Germany

FIXATION (3 months): 4% buffered formalin or Bodian's fixative



MRI imaging





Delineation (JulichBrain Section Tracer)







Sliver staining for cell bodies (each 15th)

MNI-Colin27

ICBM152 2009



Cytoarchitectonic mapping





parvicellular island



granocellular island

olfactory tubercle

Probability maps

OLFACTORY TUBERCLE



Probability maps

TERMINAL ISLANDS



Great Terminal Island 3D reconstruction in the BigBrain

- Manual expert annotations on high resolution (1μm) digitized scans
- Prediction of GTI annotations on each section based on deep learning brain mapping tool - ATLaS UI (Schiffer et al., 2021)
- Manual quality check of provided predictions
- 3D reconstruction and visualization





MicroDraw



Every 15th section

116 sections

3D reconstruction in the Big Brain



Conclusion

- The new maps provide detailed anatomical information of a complex region of the basal forebrain
- A high-resolution 3D reconstruction of the Great Terminal Island revealed its complex shape
- The new maps will support future neuroimaging studies to assess the connectivity and functions of the basal forebrain structures
- Maps are openly available through the Julich-Brain atlas available via EBRAINS







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Thank you for your attention