Brodmann (1868-1918): A pioneer of human brain mapping and his impact on present and future concepts

Monday, Jun 18: 8:00 AM - 9:15 AM
1182
Symposium
Monday - Symposia AM

The 150th anniversary of Korbinian Brodmann’s birth (17 November 1868) as well as the 100th anniversary of his death (22 August 1918) will be will be in the year 2018. Given the historical, scientific and enduring importance of his work on our field of brain mapping, the dual anniversary is exactly the right time that recognition of this pioneer and his extremely influential work should be undertaken by the OHBM at its annual meeting. He published a series of seminal contributions which represent the foundation of modern cytoarchitectonics not only of the human but also of the mammalian cerebral cortex in general. He described the cytoarchitectonic segregation of the entire cortex based on his observations. The resulting map is used for the localization of functional MRI data. It is also the fundamental database of actual atlases. Innumerable other studies are devoted to actualize his map in 3D-representations and to interpret it from a functional perspective. Although the schematic map seems to be the only aspect of his work presently used, his theoretical concepts, organizational principles of cortical areas, evolution of the cerebral cortex, fundamental conditions of its structures and possible functional implications are equally important but largely not known to the community. Only part of his work has been translated (his monography from 1909), but often not recognized in necessary detail, since his original publications comprise even more and possibly more important aspects for anatomical brain mapping.
This symposium/half-day educational course aims to remember of full spectrum of Brodmann’s work, but above all to demonstrate his influence on and importance for actual research strategies in various fields of modern neuroimaging.

Objective

1. Learn more about Brodmann's scientific concept than just using his schematic map
2. Learn facts about his life
3. Learn about present and future developments of multimodal brain maps

Target Audience

All members of OHBM (students and postdocs) who are working on the structure of the cerebral cortex, structure-function reationships, huan and animal neuroimaging, and organizational aspects of the cortex.

Co Organizer

John D. van Horn, USC Institute of Neuroimaging and Informatics

Organizer

Karl Zilles, Research Centre Juelich

Presentations

Life of Korbinian Brodmann and his concepts of cortical organization for present brain mapping projects (index.cfm?do=ev.viewEv&ev=1610)

Korbinian Brodmann was born as son of farmers on November, 17th 1868 in a little village in South-Germany. He studied Medicine at various universities in Germany. After a period as general physician, he came to the mental hospital in the little town of Alexanderbad in 1896, which was a chic spa for the upper class at this time. There he specialized in neurology and psychiatry under the supervision of Oskar Vogt, his later mentor in Berlin. In 1898, he

received his MD degree with a dissertation ”Chronic Sclerosis of Ependyma” at the University Leipzig. He spent the next two years as physician in the psychiatric hospitals of the Universities Jena (Binswanger) and Frankfurt (Alzheimer), before he joined Oskar Vogt, who was now the founder of the Neurological Institute at the University of Berlin (1901-1910), later the famous Kaiser-Wilhelm-Institute of Brain Research. He submitted his Habilitationsschrift (comparable to the PhD) on “Cytoarchitectonic parcellation of the cerebral cortex in prosimians”, but it was rejected by the University of Berlin because of intrigues of the anatomist Waldeyer and the neurologist Flechsig against his supervisor Oskar Vogt and his ambitious institute. As a consequence, he moved to the Clinic for Psychiatry and Neurology of the University Tübingen as head of the anatomy lab in 1910. At last, he was appointed as professor in Tübingen. Since 1916, he served as physician in a field hospital until the end of the First World War. 1916 he took a position as prosector in the asylum near Halle in East Germany. In 1918, he was appointed as Chief of the Department for Topographical Anatomy of the famous Research Institute for Neurology in Munich headed by Kraepelin, Alzheimer, Nissl, but he suddenly died on August 17th, 1918 before he could move to this new position because of a sepsis caused by a lesion during an autopsy. Brodmann got an education in neurology, psychiatry, psychotherapy and hypnosis. His scientific activities were focused on peripheral nerve diseases, studies using polarized light microscopy and recently introduced Nissl-staining for cytoarchitectonic observations. He also performed studies in experimental psychology, plethysmographic analysis of blood distribution in the brain during sleep, and in memory impairment, but as his pioneering and unique scientific contributions remained his cytoarchitectonic studies, particularly his famous monography from 1909. In addition to his biography, this talk will highlight his concepts on the microstructure and functional organization of the human brain and on brain evolution. These concepts are often forgotten, probably because he published exclusively in German language, but represent an extremely innovative, influential and enduring aspect of his work long before the time of neuroimaging.

Presenter

Karl Zilles, Research Centre Juelich

Next generation cytoarchitectonics – challenges and perspectives in times of Big Data (index.cfm?do=ev.viewEv&ev=1611)

Cytoarchitecture is a concept that itself encompasses different aspects of brain organization – the many cell types with distinct morphology, molecular, genetic and connectional fingerprints, which are specifically arranged in layers, columns and areas, form complex networks at the level of microcircuits or large cognitive system. Going beyond Brodmann’s cytoarchitectonic approach also means to address cytoarchitecture in 3D, at the single cell level. This is a big data challenge, not only for whole brain models, but also for volume-of-interest-models resulting, e.g. from two-photon, light-sheet imaging or electron microscopy. To integrate the different findings, to make them accessible and comparable, requires developing new tools for atlasing, data processing, analytics and visualisation. This is a challenge that is currently being addressed by international brain initiatives to open new perspective for unravelling brain complexity.

Presenter

Katrin Amunts, Research Centre Jülich

Multivariate morphological brain signatures (index.cfm?do=ev.viewEv&ev=1612)

Human neuroimaging is deeply indebted to Korbinian Brodmann. In this, the anniversary year of both his birth and his death, it is noteworthy that his name and work have been referenced in countless neuroimaging research articles using multimodal brain imaging methods. Despite other attempts to segment the brain into alternative mappings,

Brodmann’s cytoarchitechtonic areas remain an ever present frame-of-reference for studies of brain form, function, and connectivity. In this presentation I will selectively review the use of Brodmann’s reference framework across neuroimaging research studies, with a particular emphasis upon sources of variation, its use in clinical context, and its signature as being critically important for linking the future of brain research with its past.

Presenter

John D. van Horn, USC Institute of Neuroimaging and Informatics

Brodmann areas and neurochemical mechanisms (index.cfm?do=ev.viewEv&ev=1613)

Positron emission tomography (PET) and postmortem assays of regional neurochemistry have been critical tools for understanding the organization of the human brain, and for elucidating the consequences of this organization for cognitive and emotional function in health and disease. However, how these in vivo and ex vivo measurements correspond and contrast has not been comprehensively investigated. For example, on the one hand, multi-tracer PET studies measuring D1 receptors, D2, receptors, and presynaptic dopamine synthesis (DOPA decarboxylase [DDC] activity) in the same individuals provide a regionally-specific window onto the living, working human brain, and offer incisive correlates for neurofunctional and behavioral measures. Current data suggest that regulation of D1, D2, and dopamine synthesis processes are dissociable at the regional and systems level, in accord with the interacting but divergent cellular populations that these aggregate measures represent, and that Brodmann documented. On the other hand, comparative analyses across in vivo PET imaging and postmortem data offer an important validation for these widely-used neuroimaging technologies, and additionally point to important methodological considerations for clinical applications. Here, we found that strong mesostriatal signals for D2 and DDC and corticostriatal signal for D1 exist within both in vivo and ex vivo datasets, yielding robust PET-postmortem regional correspondence. Such cross-disciplinary studies hold promise for advancing our knowledge of clinical neurobiology, and potentially for improving our understanding of the genesis and treatment of serious mental illnesses. The information garnered from multimodal studies from new methods is well-conceptualized within the framework provided by Korbinian Brodmann over 100 years ago.

Presenter

Karen Berman, NIH

Automated parcellation and cortical layer analysis of the BigBrain (index.cfm?do=ev.viewEv&ev=1614)

The BigBrain dataset 1 is a 3D cytoarchitectural2 map of the human brain at 20μ isotropic resolution. Using a consensus distance-metric framework, we generated a fully-automated 3D cytoarchitectural parcellation of the BigBrain cortex3. This parcellation will be compared with the Brodmann and JuBrain atlases. We have also employed a 3D extension of the grey-level index (GLI) methodology4, combined with deep learning strategies, to identify the cortical layer structure in a fully-automated fashion. This layer analysis confirms 2D histological observations - layer IV depth was closely correlated with cortical surface curvature ($r=-0.76$, $p<0.0001$) but varied a further 20% in relative depth across cortical areas 5. The development of 3D cross-cortical analysis of laminar structure is an important development in bridging the gap between high-resolution 2D cytoarchitecture and in vivo 3D neuroimaging. 1. Amunts K et al.: BigBrain: an ultrahigh-resolution 3D human brain model. Science, 340(6139):1472-5 (2013). 2. Merker B : Silver staining of cell bodies by means of physical development. Journal of Neuroscience Methods, 9(3):235-41 (1983). 3. Fournier M et al.: BigBrain: Automated Cortical Parcellation and

Comparison with Existing Brain Atlases Proc MICCAI (2016) 4. Schleicher A et al.: Quantitative architectural analysis: a new approach to cortical mapping. J Autism Dev Disord, 39(11):1568-81 (2009) 5. Wagstyl K et al.: BigBrain: 3D automated analysis of laminar structure in the cerebral cortex (submitted)

Presenter

Alan C. Evans, McGill University