

## BOOK REVIEW

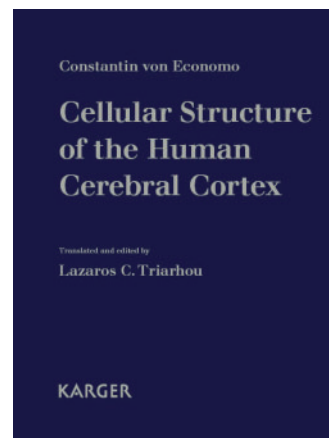
### Cellular structure of the human cerebral cortex

The publication last year of a splendid facsimile volume and translation of one of the most spectacular histological brain atlases ever produced was a major event in neuroscience that was duly acknowledged in this journal (Jones, 2008). Constantine von Economo and George N. Koskinas' *Die Cytoarchitektonik der Hirnrinde des erwachsenen Menschen*, a giant atlas made up of a boxed set of 112 large format photomicrographs and an accompanying text volume, was published as 100 sets in 1925 by Julius Springer in Vienna, the costs of production being borne by von Economo himself. The 2008 facsimile of these atlas plates was published by Karger, under the direction of Dr Lazaros C. Triarhou who also provided a translation of their German descriptions (von Economo and Koskinas, 2008). In a brief, informative accompanying chapter, Dr Triarhou, a neuroscientist, provided biographical details of the original authors and placed their work in the perspective of modern imaging studies of the human brain. Dr Triarhou clearly baulked, however, at translating the enormous text volume which ran to 810 pages with 162 figures. Instead, he has now provided us with a translation of a set of lectures in which von Economo summarized the more important features of the text. The original German version of the lectures, *Zellaufbau der Grosshirnrinde des Menschen*, illustrated with reduced copies of some of the atlas plates and many new ones, appeared in 1927; and English, Italian and French versions with introductions written by the multilingual von Economo, came soon after. But the English version by Samuel Parker, a New York psychoanalyst, was so literal a rendition of the original German to make it at times incomprehensible and in reviewing it, *Brain* was decidedly uncomplimentary (Anonymous, 1929). Happily, the French and Italian versions, translated by the neuropathologist Ludo van Bogaert and the neurologist Giovanni Mingazinni, respectively, were much more favourably received. This may explain why von Economo and Koskinas' maps of the human cortex, in which they delineated 54 fundamental cortical divisions, some of them further subdivided to give an overall total of 107, and their nomenclature, became more widely accepted in Europe than in English-speaking countries. In the latter, von Bonin and Bailey, in their atlases of the human, chimpanzee and rhesus monkey cortices, published between 1947 and 1951, were the only major users of the von Economo and Koskinas classification. Although one can still find

### CELLULAR STRUCTURE OF THE HUMAN CEREBRAL CORTEX

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lingering traces of the nomenclature and cortical subdivisions in modern works, in general the far less systematic delineation of cortical areas by numbers, as used by Brodmann (1909) and Vogt and Vogt (1929), has become more popular.

Dr Triarhou has now given us a lucid English translation of von Economo's lectures under the title of *Cellular Structure of the Human Cerebral Cortex* with additions from the larger text volume that accompanied the original atlas, in order to provide details of some regions that von Economo had omitted to discuss in his lectures. He has also discovered and translated a copy of a manuscript privately printed in Athens, in 1931, in which Koskinas summarizes the general section of the original text volume along the same lines as von Economo, making it clear that he was an equal partner in the production of the great atlas. Some of us feel that it was probably he who did most of the work!

Although the brain map and nomenclature of von Economo and Koskinas may not have passed into widespread general use, a reading of the former's introductory lecture makes it clear that they were bringing together concepts and ideas of cortical organization and structure that had been developing over the preceding 30 years and which remain with us today. Some of the terms they introduced were original, for example, 'koniocortex' for the granular cortex of the sensory areas; but by applying in a systematic way nomenclatures derived from other authors and themselves they were codifying the language that we use to describe the cortex to this day. Theirs was the first 'ontology' of the cortex, although it is doubtful that they would have understood that term in the manner in which database

experts use it today. In the scheme of von Economo and Koskinas that has come down to us, the cortex has a basic six-layered structure, each layer being named after its predominant cell type as seen in Nissl-stained preparations; thus, we have a molecular layer, an external granular layer, a pyramidal cell layer, an internal granular layer, an internal pyramidal layer and a spindle or fusiform cell layer, each numbered from I to VI. But they discerned the subdivisions of layers III, V and VI indicating that there is some arbitrariness to any fixed nomenclature, an issue that continues to exercise database experts of our times. To von Economo and Koskinas, the cortex contains three main cell types, pyramidal, granule and spindle or fusiform, again as seen in Nissl-stained preparations: they do not go into any details about the variants on these basic shapes, derived from staining with the Golgi technique, which revealed the dendritic trees and axonal ramifications of the cells. However, we still have no convention about how to name cortical neurons delineated in this manner (Ascoli *et al.*, 2008). The division of the cortex into 'isocortex' and 'allocortex', originally Vogt terms, became formalized in the lectures, as did the further division of the isocortex into granular, agranular and homotypical cortex. Where they went further than modern cortical anatomists was in making additional subdivisions of the homotypical cortex into frontal, parietal and polar types. They were always concerned with cell sizes and packing densities, with cortical thickness and the variations in architecture that depend upon cortical folding. It is a pity that the enormous amount of quantitative data of this kind provided in the original text was greatly reduced in the lectures. Dr Triarhou has included a number of tables that give us some idea of the range of these data. The naming of the 107 cortical areas was done in a systematic manner that we can only regret did not come into customary usage. In this, frontal areas are designated by F, limbic areas by L, parietal areas by P, occipital areas by O, temporal areas by T and hippocampal and adjacent areas by H. Then, each individual area within a lobe is given one or two subsidiary designations that define their location and cytoarchitectonic distinctiveness. Thus, the precentral area is FA and the giant (Betz cell) precentral area is FA $\gamma$ . They were conscious that their map of the cortical areas could only be an idealized one and that individual brains could differ considerably, an issue that continues to be confronted by modern cortical cartographers. The map is reproduced in colour in the current translation. von Economo had painted it onto a model brain to illustrate the lectures, and the model can be seen in Fig. 62 of the present translation.

The seven chapters that succeed the introductory chapter are systematic descriptions of the cytoarchitecture of the frontal, parietal, insular, occipital, temporal, superior limbic (cingulate and retrosplenial regions) and the inferior limbic (hippocampus,

dentate gyrus and uncus) lobes. In them, a reader can find spelled out the details of the variations in architecture that enable the cortical areas within each lobe to be identified, along with considerations of their relevance to localization of function, mainly as derived from the effects of lesions. The concluding lecture was not in the original German version of the lectures, but added to the English translation of Parker after von Economo had given other lectures in Paris and in New York, at the opening of New York Psychiatric Institute in 1929. It commences with a heading: *The future of cytoarchitectonics* and in it von Economo ranges widely over issues of functional localization, comparative structure and phylogeny, differences in sizes of the same areas in individual human brains, neuropathology as reflected in alterations in cellular structure, psychiatric and personality disorders, and human evolution. It is a valuable snapshot of what neurologists of his time were thinking about the cortex and its pathology and, apart from some of the phylogenetic considerations, these thoughts are just as meaningful to us today.

Dr Triarhou is to be complimented upon the manner in which he has brought the work of von Economo and Koskinas to the notice of a new generation of neuroscientists. He has done it in a way that does not simply reproduce the original works in English, but which places them in a context that makes them highly readable and relevant to anyone working on the cerebral cortex today.

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