Cytoarchitectonics of the cerebral cortex

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On 22 August 1918, a man died of septicaemia at the age of 49. His name was Korbinian Brodmann. The brain map bearing his name continued to form the basis of neurological and neuroscientific research after his death and has continued to the present day. Broadman's most significant achievement is, above all, the creation of brain maps (Fig.1)

Do you know what this brain map? This has been reprinted in neuroanatomy textbooks, research books on cranial nerves and even general books and mostly used in the world.

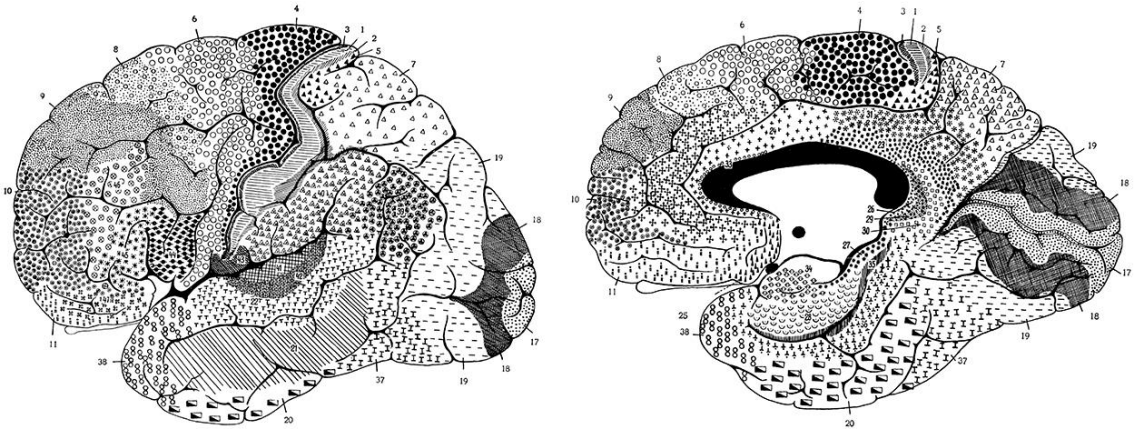

Fig. 1

Monograph on neuroanatomy published in 1909 in “Vergleichende Lokalisationslehre der Großhirnrinde in ihren Prinzipien dargestellt auf Grund des Zellenbaues” Broadman's brain map. In this book, the cerebrum is divided into 11 major regions, and 52 more subdivided areas. Why he chose 52 is a mystery. The map is said to have been first published in a journal article in 1908; the 1909 map is often reproduced, but 'another' brain map was published in 1910.

Achievements linking form and function

This map consists of two sets of diagrams of the cerebrum. The left diagram shows the brain from the outside (lateral view) and the right diagram shows the inside of the brain cut in the sagittal plane (medial view). The brain is divided into areas with various symbols (these are called 'areas') and each area is numbered. How these areas are divided is the main focus of Broadman's work.

The cerebrum, as we know, is made up of tens of billions of neurons. There are many different types of nerve cells with different morphologies and functions, and each type forms a stratified structure in the cortex. The layered structure of the cortex was known before Broadman, but different researchers had different ideas about how to divide the layers and what to call each layer. Broadman divided the cortex into six layers, which he named (1) the superficial layer, (2) the external granular layer, (3) the pyramidal cell layer, (4) the internal granular layer, (5) the neuronal layer and (6) the pleomorphic cell layer, in order from the surface. The layer names based on this Broadman classification and nomenclature are still used today.

Furthermore, Broadman found that this six-layer structure differed from place to place in the cortex. The thickness of the layers as a whole and of each layer, as well as the density of neurons, varies from place to place. For example, in the primary visual cortex, layer (4) has a thicker inner granule layer, while layer (4) is thinner in the primary motor cortex, layer (5) has a thicker neuronal layer and giant pyramidal cells (Betz cells) are present. This layered structure was investigated in the entire cortex and divided into 52 areas, based on similarities and differences in the layered structure. This information was mapped onto a diagram of the cerebrum and visualized as the Broadman brain map.

Broadman's brain map is, in other words, a map of brain areas based on differences in form, but why did such a map become a major guide for subsequent researchers? It was because differences in form were linked to differences in function. As I mentioned earlier, the differences in the layered structure (morphology) of the primary visual cortex and primary motor cortex often coincide with the division based on 'what it looks like' and the division based on 'what it does'. This is because certain neurons are needed to carry out the functions of the area and, conversely, certain types of neurons are not needed, and this need/need is reflected in the layered structure (although this causal relationship may be reversed). This makes the map very attractive to neurologists seeking to understand the brain.

Actually Broadman's map is incomplete

Contrary to his achievements, which have remained unblemished for more than a century, Broadman was surprisingly not a gifted researcher in his early life: after qualifying as a doctor at the age of 26, he moved from one research establishment to another in Germany. Finally, in April 1918, four months before his sudden death, he was invited to head the Department of Local Anatomy and Histology at the German Institute of Psychiatry (now the Max Planck Institute of Psychiatry), established by Emil Kraepelin (1856-1926), the head of German psychiatry at the time. This was. He must have been trying to further refine his brain maps here. This is because, although it is not widely known, his brain map is 'incomplete'.

What this means is that the brain map is not all numbered 1-52, but there are some missing numbers (fields 12-16, 48-51). In addition, there are actually two types of brain maps: one published in 1909 and one published in 1910, and although they appear to be the same at first glance, the latter has been modified by the addition of the missing field 12. Furthermore, the same brain map of 1910 was republished in the 1914 review, but with a caption that was not present in 1910, showing how Broadman's ideas had been updated over the years. There is no point in bringing 'what ifs' into history, but it would be fascinating to see what changes would have been made to the brain maps had Broadman lived longer.
Why was Broadman the only one to popularize the idea?

The idea of examining the microstructure of the cortex and demarcating areas based on this is not unique to Broadman. Before Broadman, the Australian Campbell (Alfred Walter Campbell; 1868-1937) had divided the cerebrum into about 20 regions, and Broadman's collaborator Forkt (Oskar Vogt; 1870-1959) had studied the neuronal fibers, not the cellular architecture. The cerebrum is subdivided into as many as 200 regions based on myelin architecture, which looks at the distribution of the myelin sheath.

However, of all the brain maps available, why has only Broadman's become so popular? I see three reasons: first, he did not name the areas but assigned numbers to them. The classification by numbers, which are difficult to imply meaning, transcends language barriers and allows everyone to understand at a glance which domain it is. Another is the number 52. The number is not too large, not too small, and the year consists of 52 weeks (and one day), and the number is a superposition of the 26 basic letters of the Latin alphabet, so it is a number with a high degree of affinity.
We will discuss about his great work and try to interpret his original concept while adapting to the angioarchitecture of the AVMs and other pathology.

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