BRAIN and NERVE 69 (4) : 301-312, 2017 Topics

Korbinian Brodmann's scientific profile, and academic works

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Abstract

Brodmann's classic maps of localisation in cerebral cortex are both well known and of current value. However, his original 1909 monograph is not widely read by neurologists. Furthermore, he reproduced his maps in 1910 and 1914 with a number of important changes. The 1914 version also excludes areas 12-16 and 48-51 in human brain while areas 1-52 are described in animal brain. Here, we provide a detailed explanation of the different versions, and review Brodmann's academic profile and work.

Key words: Brodmann's map; missing numbers; Brodmann's profile; Brodmann's works; infographics

Introduction

The following paper is based on a Japanese language version (BRAIN and NERVE, April 2017) by MK.

Recently I developed a passion for the design of charts and diagrams and enjoy looking through books on infographics. The design of visual information has made remarkable progress in recent years. Furthermore, figures, tables, and graphic records are on the agenda at every editorial meeting of *Brain And Nerve*.

The maps of Korbinian Brodmann (1868-1918) were first published in German in 1909[1], and I believe they rightly belongs to infographics since they localise neuroanatomical information onto human and animal brain – monkey, for example – using the techniques of histology and comparative anatomy. Unlike the cerebellar cortex, which has a generally uniform three-layer structure throughout, most of the cerebral cortex has a six-layer structure of regionally diverse patterns. This diversity was first used to classify brain areas and their associated human functions not only by Brodmann but also by others including Alfred Walter Campbell (18681937) in Australia[2], Oskar Vogt (1870-1959) in Germany[3], and two Greek researchers active in Vienna: Constantin von Economo (1876-1931) and Georg N. Koskinas (1885-1975)[4].

In 1903 Campbell divided the brain into 20 areas but did not number them. Charles Scott Sherrington (1857-1952) used these divisions in his experiments to stimulate animal brain areas[5]. Vogt and his wife distinguished about 200 small areas, then used by Otfrid Foerster (1873-1941) in his research[5]. The maps of von Economo and Koskinas, generally based on Brodmann's, had about 100 cerebral areas labeled by alphabetic combination. Of all these maps, Brodmann's are those most frequently used, while those of von Economo and Koskinas are used in neurophysiological research in monkey. Furthermore, the work of von Economo and Koskinas published in 1925 – being the latest – is highly valued for its accuracy.

I start this review by presenting a map newly devised as an aid to readers of this special issue. This juxtaposes the maps of Brodmann with those of von Economo and Koskinas. My second objective is to provide a corrected version of Brodmann's cerebral areas in light of recent knowledge. I also introduce his life and work as necessary background information.

Comparison Of Two Brain Maps: Brodmann versus von Economo And Koskinas

Professor Hirayama and I, in our book *MRI-Cerebral Topodiagnosis* published in 1993[6], provide a comparative table detailing 1) Brodmann areas, 2) von Economo and Koskinas' cortical areas, and 3) anatomical terms (Table 1). This is because we thought we would not be alone in benefitting from an at-a-glance list integrating Brodmann, extensively used by neurologists and neurosurgeons, von Economo and Koskinas, used by brain scientists, plus common terms of neurological reference. While this table was already an example of infographics, we also created figures 1 and 2 with the intention of making a visual guide for this special, enlarged issue of *Brain And Nerve*. Figure 1 was directly generated from Table 1. Figure 2 is a cortical map of monkey brain generated using the same idea. Because no comparative table exists for monkey brain, Brodmann areas of guenon (or lower monkey) were both color and alphabetically coded to rhesus macaque drawn by von Bonin and Bailey based on von Economo and Koskinas. Both the guenon and the rhesus macaque belong to the Cercopithecidae, and are thought to have cerebral similarities such as sulcal patterns. In this map clear boundaries were drawn for clarity, but it should be noted that Brodmann's own map is known for its ambiguous boundaries between areas.

In 1983 Sakata created "functional cortical maps of human and monkey brains"[7]. These were monochrome maps of human and monkey brains annotated with cytoarchitectonic boundaries and functional areas as identified at that time, and primarily based on von Economo and Koskinas with Brodmann area numbers. Sakata's maps, I would like to say, inspired me to create my own.

Given that Brodmann studied not only human and monkey brain but also that of other animals including guenon, marmoset, kinkajou, and rabbit,[8] any rigorous discussion would require comparison across animal species. However, this review focuses on human and monkey brain because monkeys are the most frequently studied of non-human animals.

Interestingly, Brodmann is said to have studied human brains for the first time in 1903 when he analyzed those of three adults, two infants, and two fetuses.[9] And in 1905, using monkey brains, he created his first brain map of 28 areas.[10] He mapped the human brain, I discovered, three years later in 1908.[9]

I. Brodmann's 11 Regions And 52 Areas

In his monograph of 1909 Brodmann divided the brain into 11 major "Regionen" (regions) and 52 subdivisions or "Felder" (areas).

Figure 3 and Table 2 show Brodmann's 11 regions. While this map is not widely known it is, I believe, of contemporary importance to our understanding of his ideas.

In contrast, far greater recognition goes to the brain map showing 52 areas published in the same monograph. Few anatomical textbooks fail to include this, and it is sometimes reproduced in lay books on the brain. Its widespread recognition is due not only to its relatively modest number of 52 areas but also to its number coding. Furthermore, the combination of a number with a function, for example (4) for motor cortex and (17) for the visual cortex, makes it easy to remember.

Table 3 compiles Brodmann's own articles leading up to his 1909 monograph. He began by observing the Rolandic region of the human brain, moved on to the pericalcarine region, and subsequently observed the cortex of primates such as the guenon. He published his brain map for the first time in his 9th article (dated by him "1907" but published in 1908): see reference 9. This map was then reproduced in his 1909 monograph.

However, examination of the 1909 monograph reveals that part of area 35 had formerly been designated as area 48. Furthermore, Brodmann says that area 11 can be further subdivided.

This suggests that Brodmann's research was still in progress. In addition, number 52, the last of his areas, was assigned to the medial aspect of the Sylvian fissure (Fig. 4), despite the lack of numbers from 48-51. This suggests, I believe, that in 1909 Brodmann planned to divide the brain into a total of 52 areas.

Why he chose 52 is unclear. A year has 52 weeks (and a day). A modern piano has 52 white keys. The Latin alphabet has 26 letters, and twice 26 is 52. Adopting neither the letter combinations, as used by von Economo and Koskinas, nor the elaborate mapping of the Vogts, Brodmann divided his brain map into a relatively simple 52 areas, and this may be the reason for its lasting and widespread use.

II. Missing Numbers And Two Brain Maps

Brodmann started his cytoarchitectonic study of the cerebral cortex in 1901 when he moved to the laboratory of Oskar Vogt and his wife, Cécile, in Berlin. And he was most active while in Berlin between 1901 and 1910. His findings during this period were published in seven articles from 1903 to 1908 (Table 3). And the compilation of these papers was published as a monograph in 1909 that earned his work worldwide recognition. While in Berlin, he also wrote a review[11], then included in a monograph published in 1910. We will revisit this review later. Figure 5 shows Brodmann at work in the laboratory in Berlin with Oskar and Cécile Vogt.

In the 1909 monograph, Brodmann provisionally numbered animal brain areas from 1 through 52. However, numbers 12 -16 and 48-51 were missing, as shown in Table 1[6,9,12-14].

Let me explain the background to classification of cortical areas based on layer structure by quoting Kobayashi et al.[15].

> The second half of the nineteenth century witnessed the initiation of brain mapping based on the microscopically observed characteristics of cortical areas. Just as Betz marked out what is currently called the motor cortex by using giant pyramidal cells as the index, early attempts tried to identify brain areas using a limited number of shared cortical characteristics. Consequently, identified areas were limited only to those with distinct characteristics, and many other areas were left unclassified in the vast cerebral cortex. Most of the human cerebral cortex consists of six layers: layer I, the molecular layer; layer II, the external granular layer; layer III, the external pyramidal layer; layer IV, the internal granular layer; layer V, the internal pyramidal layer; and layer VI, the multiform layer. Efforts to classify the entire cerebral cortex through comprehensive analysis of the cortical layer structure, encompassing the thickness of the entire cortex and of each individual layer as well as cell sizes and densities, made progress in the early twentieth century. Representative figures include: Vogt who focused on myeloarchitecture, Campbell who relied on cytoarchitecture, Brodmann, and von Economo.

Kobayashi et al. continue:

> Vogt made a detailed classification of the entire cortex based on myeloarchitecture: the distribution of intracortical myelinated fibers, represented by the deepest layer reached by myelinated fibers from the myelin sheaths and by the layer densely populated with horizontally oriented myelinated fibers. Contrastingly, Campbell, Brodmann, von Economo and others based their classifications on the density, size, and morphology of Nissl-stained nerve cells. Irrespective of the approach, boundaries are similar in most areas . . .. These basic traits show us why areas sending cortico-nuclear and cortico-spinal fibers, such as area 4, have well-developed pyramidal cells in layer V, and why layer IV develops in areas such as 17 (primary visual cortex) that contain the terminals of numerous fibers transmitting visual signals from the lateral geniculate nucleus in the hypothalamus. This is the reason why, despite the morphological basis, classification of the cerebral cortex based on layer structure agrees in most cases with function.

These explanations confirm the importance of classifying brain areas on the basis of layer structure. Morphological characteristics, in this case the layer structure underpinning the classification of cortical areas, often match function.

Apart from his classic, 1909, brain map, Brodmann also presented another [6,9,13,14]. In 1993, in *Neurology*[12], Gorman et al. published a paper entitled “Brodmann’s ‘missing’ numbers”. And although this attracted interest, it failed to mention Brodmann’s other brain map.

Figure 6 presents Brodmann’s two brain maps, the first published in 1909 and the second in 1910. Furthermore, the maps of 1910 and 1914 are identical aside from the legend provided for the 1914 map. The most important point is that the 1910 map differs from that published in the classic 1909 monograph. Brodmann wrote the review of 1910 (about 100 pages) in Berlin where he had written his original, 1909 monograph. The review of 1914 (about 300 pages) was written in Tübingen after leaving Berlin. The 1910 and 1914 maps show area 12, which was absent in the 1909 map, adjacent to area 11, the orbitofrontal cortex [8,17]. Furthermore, area 7 was subdivided into areas 7a and 7b, and area 44a added to area 44. The legend to the 1914 map states that areas 13-16 represent the insular cortex –a fact corroborated by Gorman et al.[12].

Brodmann’s brain map is now ubiquitous: reproduced both in neuroanatomical textbooks and books for general readership. While the 1909 monograph is usually cited as the source, the maps from 1910 or 1914 are often reproduced. At a glance these appear to be the same, but the misattribution is of concern because of area 12 in the orbitofrontal cortex – an important brain region attracting recent attention[8]. While confusion between the 1909, 1910 and 1914 maps is understandable, it is necessary to remember that the 1910 and 1914 maps best represent Brodmann’s final ideas, and their importance, in my opinion, exceeds that of the 1909 map.

III. Drawings Of Cortical Layer Structure

In addition to his brain maps, Brodmann also left important drawings (Fig. 7). These well known drawings are published in many textbooks, and their source is the 1910 monograph[11]. Slices of cerebral cortex stained using Golgi, Nissl, and Weigert techniques (left to right) are shown side by side. Each slice clearly shows the characteristics of each staining method and well visualizes cortical layer structure. These same drawings were included in Carpenter’s textbook[18] that I read as a medical student.

The following is taken from Iwama[13] :

> According to Carpenter... the source of these drawings* is Brodmann’s 1909 monograph, which, however, did not contain them. These drawings were printed beautifully in the 1910 monograph, occupying an entire page. Part of its legend applies to vertical axes on either side of the drawings. It says that Roman numerals on the left axis stand for cellular layers according to Brodmann, while Arabic numerals on the right axis stand for fiber layers according to Vogt. There is also an explanatory note that these are "schematisch" (schematic) drawings.
>
> * Fig. 7 of this review Iwama concludes:
>
> The main text says nothing about the background of the drawings. After all, these drawings were provided merely as an illustrated aid to the reader.

These drawings, often reproduced in later textbooks, and under appreciated, reveal one of Brodmann’s key merits as a researcher. That is, he had a strong desire to present information in a manner easily understood.

IV.Brodmann's Life And Work

Korbinian Brodmann (17 November 1868 - 22 August 1918) died at the early age of 49. He was the eldest son of a farming family in Liggersdorf, a small town near Lake Constance in southwest Germany. Nowadays, while Liggersdorf is in Germany, its nearest airport is Zürich, Switzerland.

Liggersdorf now has a museum founded partly by Brodmann's only daughter. The house of his birth still stands, and its entire second floor serves as the museum. I visited this in June 2016 on a warm summer day – leaving Berlin in the morning and arriving at Zürich Airport before noon. The museum's walls are decorated with photographs of the hospitals and laboratories where he worked (Fig. 8). These chart his life and, in particular, his medical and academic career.

Figure 9, after one of the museum panels, shows Liggersdorf of the time, his parents, and his birthplace. Following his parents' wishes he attended university, obtaining a leaving certificate from the gymnasium at the rather late age of 21.

Following Iwama[13] , Table 4 is a chronological list of Brodmann's career moves[19-25]. As shown, Brodmann worked as a physician and researcher moving from place to place, married at 48, and had one child. He accepted a post offered by Emil Kraepelin but then died at the young age of 49 in the middle of his promising academic career. The centennial of his death was thus 2018.

Afterword

In early 1993, I was engaged in final proofreading of *MRI-Cerebral Topodiagnosis*[6]: a book written in collaboration with my mentor, Professor Keizo Hirayama. Having completed the task, I once again compared historical brain maps with the findings discussed in our textbook. We then decided to compile a comparative table linking Brodmann areas and the anatomical terms for their respective brain regions (prototype of Table 1). Our idea was not to start by listing anatomical terms but to find anatomical terms matching respective Brodmann area numbers. Area codes following von Economo and Koskinas were also inserted between Brodmann area numbers and anatomical terms.

In the course of this task, I noticed that some numbers were missing from the so-called 52 areas. Two papers on missing Brodmann numbers happened to be published in this same year: The first, in English, by Gorman et al.[12] and the second, "Notes about Korbinian Brodmann," a paper in Japanese by Iwama – published by the now discontinued journal, *Microscopia*[13]. My views on these papers was published in *Igakukaishinbun* (a weekly medical newspaper in Japanese)[14].

I have since then been thinking a lot about Brodmann area 12[8], and the idea behind this special enlarged issue is part of that. I believe that more studies will investigate the functions of specific brain areas aided by diverse imaging techniques, and that these will benefit from the 18 papers in this special enlarged issue.

Finally, let me conclude this article on a personal note. In my opinion, Brodmann was not only an excellent physician and anatomist but also something of a genius with regard to infographic communication. He had an exceptional desire to express intrinsically complicated matters as simply as possible, and I believe this is why his maps stands out, as do his drawings of histological anatomy (Fig. 7).

Acknowledgement

Supported by a Grants-in-Aid for Scientific Research (also known as KAKENHI) for Innovative Areas (JP25119006; JP18H05525).

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[Tables]

Table 1 A Comparison Of Cortical Area Descriptions

Brodmann areas	von Economo-Koskinas areas	Anatomical terms
1	PC	Intermediate postcentral gyrus
2	PD	Caudal postcentral gyrus
3	PA1, PB	Rostral postcentral gyrus
4	FA	Superior and posterior middle to inferior parts of precentral gyrus, anterior paracentral lobule
5	PA2	Supracaudal postcentral gyrus, caudal paracentral lobule, suprarostral superior parietal lobule
6	FB	Posterior superior and middle frontal gyrus, middle and inferior middle precentral gyrus
7	PE	Superior parietal lobule
8	FC	Middle superior and middle frontal gyrus
9	FD	Anterior superior frontal gyrus, middle frontal gyrus
10	FE	Frontal pole
11	FH, FG	Orbital gyri, straight gyrus
12*		
13		
14		
15	**	
16		
17	OC	Striated area (inferior cuneus, superior lingual gyrus, occipital pole)
18	OB	Margin of striated area (parts of first, second, and third occipital gyri, descending gyrus, cuneus, and lingual gyrus)
19	OA	Periphery of area 18
20	TE_2	Inferior temporal gyrus
21	TE_1	Middle temporal gyrus
22	TA	Middle and posterior superior temporal gyrus
23	$LC_{2,3}$	Ventral posterior cingulate gyrus
24	LA	Ventral anterior cingulate gyrus
25	FL, FM, FN	Subcallosal gyrus (posterior subgenual cortex)
26	LF, LB_2	Isthmus of cingulate gyrus

27	HD	Parahippocampal gyrus (area contacting subiculum)
28	HB, HC	Entorhinal area (anterior parahippocampal gyrus)
29	$LE_{1,2}$	Isthmus of cingulate gyrus
30	LD	Isthmus of cingulate gyrus
31	LC_1	Dorsal posterior cingulate gyrus, inferior precuneus
32	FCL, FDL, FEL, FHL	Superior and middle medial frontal gyrus
33	LB_1	Cingulate area of anterior cingulate gyrus in callosal sulcus
34	HA	Dorsal entorhinal area (uncus)
35	TGa, THa	Perirhinal area
36	TF	Fusiform gyrus
37	PH	Posterior middle and inferior temporal gyrus, posterior fusiform gyrus
38	TG	Temporal pole
39	PG	Angular gyrus
40	PF	Supramarginal gyrus
41	TC	Transverse temporal gyrus (transverse gyrus of Heschl)
42	TB	Superior aspect of superior temporal gyrus, posterior to area 41 (temporal plane)
43	PD, PF	Connection between precentral and postcentral gyri (base of central sulcus)
44	FCBm	Pars opercularis of inferior frontal gyrus
45	FD¬	Pars triangularis of inferior frontal gyrus
46	FDΔ	Middle precentral gyrus, rostral inferior frontal gyrus
47	FF	Orbital inferior frontal gyrus
48***		
49		
50		
51****		
52	IBT	Boundary between insular cortex and temporal operculum

* Brodmann's cytoarchitectonic map of the human brain[1] has no area numbered 12. However, in the map of monkey brain, the frontal pole is numbered 12 and annotated as corresponding to human area 11 (p156). In the 1914 map, the orbital gyrus within area 11 is numbered 12. Von Economo and Koskinas make no mention of an area 12[4].

** Brodmann's human brain map[1] has no areas numbered13-16, while in his monkey map the insular cortex does have these numbered areas: see Gorman et al.[12] This was also noted by von Economo and Koskinas[4]. In my opinion, they probably compared their mapping against Brodmann's 1909 monograph[1] in which there is no area 12. The same applies to areas 48-51: von Economo and Koskinas (p499) comment on the insular cortex as follows:

Brodmann divided the insular cortex into two major parts: "Area insularis paracentralis" and "Area insularis postcentralis." He did not describe the cytoarchitecture of the insular cortex. His description of animal insular cortex is referred to as follows: Area 13 = Area insulae posterior: IB, area 14 = Area insularis anterior: IA, area 15 = Area insularis ventralis (orbitalis): IC, area 16 = Area insularisoralis (olfactoria): FK or FI.

Von Economo and Koskinas conducted their research on insular cortex in comparison with Brodmann's research on animal brains. Brodmann thought animal insular cortex could be classified into four areas, but did not number them. Consequently, in this table, areas of the insular cortex are left blank.

*** Brodmann commented that part of area 35 had formerly been referred to as area 48 (p150)[1].

**** These numbers are not assigned in Brodmann's human map[1], but are assigned in the maps of some animal species.

With modifications after: Keizo Hirayama and Mitsuru Kawamura, *MRI-Cerebral* Topodiagnosis, Igaku Shoin, Tokyo, 1993.

Table 2 Brodmann's 11 Cerebral Regions

1	Regio postcentralis	Postcentral region	Areas 1, 2, 3, 43 (4 areas)
2	Regio precentralis	Precentral region	Areas 4, 6 (2 areas)
3	Regio frontalis	Frontal region	8, 9, 10, 11, 44, 45, 46, 47 (8 areas)
4	Regio insularis	Insular region	13, 14, 15, 16 (4 areas)
5	Regio parietalis	Parietal	5, 7, 39, 40 (4 areas)
6	Regio temporalis	Temporal region	20, 21, 22, 36, 37, 38, 41, 42, 52 (9 areas)
7	Regio occipitalis	Occipital region	17, 18, 19 (3 areas)
8	Regio cingularis	Cingulate region	23, 24, 31, 32, 33, 25 (6 areas)
9	Regio retrosplenialis	Retrosplenial region	26, 29, 30 (3 areas)
10	Regio hippocampica	Hippocampal region	27, 28, 34, 35 (4 areas)
11	Regio olfactoria	Rhinal region	

Based on Brodmann K: Vergleichende Lokalisationslehre der Großhirnrinde in ihren Prinzipien dargestellt auf Grund des Zellenbaues. Barth, Leipzig, 1909

Table 3 Brodmann's List Of His Own Publications

Beiträge zur histologischen Lokalization der Großhirnrinde.

(1) I. Mitteilung: Die Regio Rolandica. Journ. f. Psych. u. Neurol. 2, 1903.
(Die Regio Rolandica: Rolandic region)

(2) II. Mitteilung: Der Calcarinatypus. Ebenda 2, 1903.
(Der Calcarinatypus: pericalcarine region)

(3) III. Mitteilung: Die Rindenfelder der niederen Affen. Ebenda 4, 1905.
(Rindenfelden der niederen Affen: cortices of lower primates)

(4) IV. Mitteilung: Der Riesenpyramidentypus und sein Verhalten zu den Furchen beider Karnivoren. Ebenda 6, 1905.
(Karnivoren: carnivores)

(5) V. Mitteilung: Über den allgemeinen Bauplan des Cortex pallii bei den Mammalien und zwei homologe Rindenfelder im besonderen. Zugleich ein Beitrag zur Furchenlehre. Ebenda 6, 1906.

(6) VI. Mitteilung: Die Cortexgliederung des Menschen. Ebenda 10, 1907.

(7) VII. Mitteilung: Die cytoarchitektonische Cortexgliedrung der Halbaffen. Ebenda 10: 1908.
(Ergänzung sheft)

(8) Über Rindenmessungen. Zentralbl. f. Nervenh. u. Psychiatr. 19, 1908.

(9) Demonstrationen zur Cytoarchitektonik der Großhirnrinde mit besonderer Berücksichtigung der histologischen Lokalisation bei einigen Säugetieren. (Vortrag auf der Versammlung deutscher Psychiater, 1904.) Allg. Zeitschr. f. Psychiatr. 61, H. 5, 1904.

This list reveals the sequence of Brodmann's research from the Rolandic to the pericalcarine regions and then on to primate brains. No.s 1-7, published in *Journal für Psychologie und*

Neurologie, share a common title: “Beiträge zur histologischen Lokalisation der Großhirnrinde.” No. 6, which Brodmann dates 1907, was published in 1908.

Table 4 A Chronology Of Brodmann’s Career

1868	Born 17 November, Liggersdorf, Southern Germany. Studied at Munich, Würzburg, Berlin, and Freiburg.
1895	Qualified in medicine (age 26).
1896	Worked at the Neurology Clinic in Alexanderbad. Met Oskar Vogt (age 27).
1898	Doctorate conferred at Leipzig for a thesis on chronic ependymal sclerosis (age 29).
1900	Worked at a mental hospital in Frankfurt. Acquainted with Alois Alzheimer (age 31).
1901	Moved to Neurobiological Central Station (Berlin) founded by the Vogts. Started research on cerebral areas using cytoarchitectonic techniques.
1910	Moved to the Psychiatry Clinic in the University of Tübingen. Also started research in the anatomy laboratory of the same university. Promoted from assistant physician (Assistenzarzt) to senior physician (Oberarzt) and then to associate professor (Privatdozent) (age 41).
1913	Became extraordinary professor (ausserordentlicher Professor) at the same clinic (age 44).
1916	Moved as prosector to a mental hospital in Nietleben (age 47).
1917	Married Margarete Franke (age 48).
1918	In April, Emil Kraepelin founded the German Research Institute for Psychiatry (present-day Max Planck Institute for Psychological Research) in Munich and invited Brodmann to be Head of the Department of Topographical Anatomy. Died of sepsis on 22 August (age 49).

[Legends]

Fig. 1 Comparison of two human brain maps: Brodmann versus von Economo and Koskinas

Based on Hirayama K, Kawamura M: MRI-Cerebral Topodiagnosis. Igaku Shoin, Tokyo, 1993.

Human, lateral view

Human, insular cortex

Human, medial view

Fig. 2 Brodmann’s map of monkey brain numbered after von Economo and Koskinas

Brodmann studied the guenon, while von Bonin and Bailey studied the macaque. Both primate species belong to the Cercopithecidae. Brodmann areas are identified by colors and labeled with the letter codes of von Economo and Koskinas according to von Bonin and Bailey.

Based on Brodmann K: Vergleichende Lokalisationslehre der Großhirnrinde in ihren Prinzipien dargestellt auf Grund des Zellenbaues. Barth, Leipzig, 1909, von Bonin G, Bailey P: The Neocortex of Macaca mulatta. Allen RB, Kampmeier OF, Schour I, Serles ER (eds): Illinois Monographs in the Medical Sciences, Vol.5. The University of Illinois Press, Urbana, 1947, pp1-163, and Sakata H: Localism and holism. Kagaku 53: 210-213,1983.

Primate, lateral view

Primate, medial view

Fig. 3 Brodmann's 11 Cerebral Regions

Brodmann divided the brain into 11 major regions, which he further subdivided into 52 areas. The 11 regions are shown in Table 2. In this figure, Regio olfactoria (rhinal region) is not shown, and had not yet been clearly located according to the legend.

Reproduced from Brodmann K: Vergleichende Lokalisationslehre der Großhirnrinde in ihren Prinzipien dargestellt auf Grund des Zellenbaues. Barth, Leipzig, 1909.

Fig. 4 Brodmann's Map Of Human Insular Cortex And The Pars Opercularis

The boundary between the insular cortex and the temporal lobe is numbered 12.

Reproduced from Brodmann K: Vergleichende Lokalisationslehre der Großhirnrinde in ihren Prinzipien dargestellt auf Grund des Zellenbaues. Barth, Leipzig, 1909.

Fig. 5. The Vogts and Brodmann

A photograph (1904) displayed at the Brodmann Museum. This was taken in the Neurobiologisches Laboratorium, Magdeburger Str. 16. From left to right: Brodmann, Cécile Vogt, Oskar Vogt, Bosse, Borchert, and Lewandowsky.

Fig. 6 Comparison Of Brodmann's Two Brain Maps, Published In 1909 (Left) And 1910 (Right)

Reproduced from Brodmann K: Vergleichende Lokalisationslehre der Großhirnrinde in ihren Prinzipien dargestellt auf Grund des Zellenbaues. Barth, Leipzig, 1909 and Brodmann K: Feinere Anatomie des Großhirns. Lewandowsky M (ed): Handbusch der Neurologie. Springer, Berlin, 1910, pp206-307.

Fig. 7 The Six Layers Of The Cerebral Cortex Published

in the 1910 monograph.

Reproduced from Brodmann K: Feinere Anatomie des Großhirns. Lewandowsky M (ed): Handbusch der Neurologie. Springer, Berlin, 1910, pp206-307.

Fig. 8 Brodmann's Career

After a display at the Brodmann Museum. As a physician and researcher, Brodmann moved from place to place in Germany. He was fortunate in that he met leading researchers in the places he worked (see Table 4).

Fig. 9 One Of The Panels Displayed At The Brodmann Museum

This shows photographs including one of Liggersdorf when Brodmann lived there, and of his parents, and birthplace.