Supplementary Material

Brodmann: A pioneer of human brain mapping - his impact on concepts of cortical organization

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BRAIN (2018) Doi: 10.1093/brain/awy273

Supplementary Table 1: Published work of Korbinian Brodmann

Citation	Title	Brief description of the content
Bielschowsky M and Brodmann K (1905) J Psychol 5: 173-199	Zur feineren Histologie und Histopathologie der Großhirnrinde mit besondere Berücksichtigung der Dementia paralytika, Dementia senilis und Idiotie	Neuropatholgy of the dementia paralytica and dementia senilis
Brodmann K (1897) Zeitschr Hypnotism 6: 1-10	Zur Methodik der hypnotischen Behandlung. Erste Mitteilung	Methodologic considerations about hypnotic treatment
Brodmann K (1898a) Inaugural Dissertation. Leipzig: Metzger und Wittig	Ein Beitrag zur Kenntnis der chronischen Ependymsklerose	Neuropathology of chronic sclerosis of the ependyma
Brodmann K (1898b) Zeitschr Hypnotism 7: 1-35, 228-246, 266-284	Zur Methodik der hypnotischen Behandlung. Zweite bis vierte Fortsetzung	Methodologic considerations about hypnotic treatment
Brodmann K (1899) Zschr Med Naturw 33/N.F. 26: 181-189	Über den Nachweis von Astrozyten mittels der Weigertschen Gliafärbung nebst Demonstration von Präparaten	Histological staining method for astroglia
Brodmann K (1900) Münch med Wschr 47: 829-832, 868-870	Neuritis ascendens traumatica ohne äußere Verwundung	Clinical report on neuritis traumatica
Brodmann K (1901) Zbl Nervenhk 24/N.F. 12: 193-213	Die Anwendung des Polarisationsmikroskops auf die Untersuchung degenerierte markhaltiger Nervenfasern	Use of a polarizing microscope for the analysis of degenerating myelinated fibers
Brodmann K (1902) Zschr Hypnotism 10: 314-375	Zur Methodik der hypnotischen Behandlung. 5. Fortsetzung und Schluß	Methodologic considerations about hypnotic treatment
Brodmann K (1902-03a) J Psychol 1: 225-246	Experimenteller und klinischer Beitrag zur Psychopathologie der polyneuritischen Psychose, A: klinischer Teil	Clinical report on polyneuritic psychosis
Brodmann K (1902-03b) J Psychol 1: 10-71, 84-88	Pletysmographische Studien am Menschen. Erster Teil. Untersuchungen über das Volumen des Gehirns und des Vorderarms im Schlafe	Blood flow in the brain
Brodmann K (1903a) J Psychol Neurol 2 79-107	Beiträge zur histologischen Lokalisation der Grosshirnrinde. Erste Mitteilung: Die Regio Rolandica	Histological localization of the primary motor cortex in the human brain
Brodmann K (1903b) J Psychol Neurol 2 133-159	Beiträge zur histologischen Lokalisation der Grosshirnrinde. Zweite Mitteilung: Der Calcarinatypus	Histological localization of the primary visual cortex in the human brain

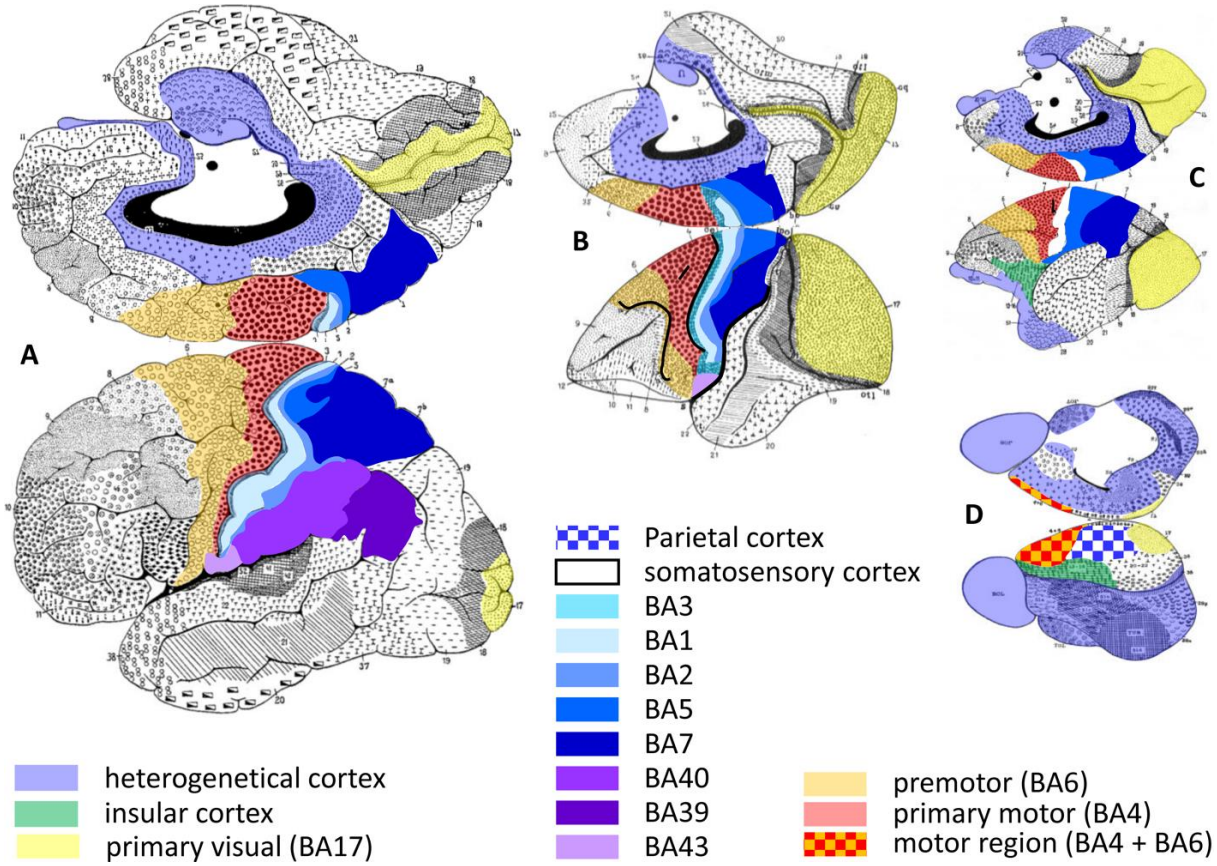
Brodmann K (1904) J Psychol 4: 1-48	Experimenteller und klinischer Beitrag zur Psychopathologie der polyneuritischen Psychose, B Experimenteller Teil	Experimental report on polyneuritic psychosis
Brodmann K (1905a) J Psychol Neurol 4 177-226	Beiträge zur histologischen Lokalisation der Grosshirnrinde. Dritte Mitteilung: Die Rindenfelder der niederen Affen	Histological localization of cortical areas in prosimians and monkeys
Brodmann K (1905b) J Psychol Neurol 6 108-120	Beiträge zur histologischen Lokalisation der Grosshirnrinde. Vierte Mitteilung: Die Riesenpyramidentypus und sein Verhalten zu den Furchen bei den Karnivoren	The relation of the primary motor cortex to sulci in carnivores
Brodmann K (1906) J Psychol Neurol 6 275-400	Beiträge zur histologischen Lokalisation der Grosshirnrinde. Fünfte Mitteilung: Über den allgemeinen Bauplan des Cortex pallii bei den Mammalieren und zwei homologe Rindenfelder im Besonderen. Zugleich ein Beitrag zur Furchenlehre	Homologue cortical areas in mammals and their relation to sulci and gyri
Brodmann K (1907) Neurol Zbl 26: 338-349	Bemerkung über die Fibrillogenie und ihre Beziehungen zur Myelogenie mit besonderer Berücksichtigung des Cortex cerebri	Development of axons and myelinated fibers in the cerebral cortex
Brodmann K (1908a) J Psychol Neurol 10 231-246	Beiträge zur histologischen Lokalisation der Grosshirnrinde. VI. Mitteilung: Die Cortexgliederung des Menschen	Cortical localization in the human brain
Brodmann K (1908b) J Psychol Neurol 10 287-334	Beiträge zur histologischen Lokalisation der Grosshirnrinde. VII. Mitteilung: Die cytoarchitektonische Cortexgliederung der Halbaffen (Lemuriden)	Cortical localization in the cerebral cortex of prosimians
Brodmann K (1908c) Zbl Nervenhk 31/N.F. 19: 781-798	Über Rindenmessungen	Quantitative data (surface) of the cerebral cortex
Brodmann K (1909) Leipzig: Barth	*Vergleichende Lokalisationslehre der Grosshirnrinde in ihren Prinzipien dargestellt auf Grund des Zellenbaues*	Monography on the localization of cortical areas in mammalian brains including the human brain
Brodmann K (1910) Berlin: Springer. Pp. 206-307	*Feinere Anatomie des Großhirns.* In: M. Lewandowsky (Ed.) Handbuch der Neurologie. Band 1.	Textbook-like chapter on the telencephalon
Brodmann K (1912) Verh Anat Ges Jena 41: 157-216	Neue Ergebnisse über die vergleichende histologische Lokalisation der Großhirnrinde mit besonderer Berücksichtigung des Stirnhirns	Comparative analysis of the frontal lobe in mammalian brains
Brodmann K (1913) Verh Ges Dtsch Naturf Ärzte 35: 200-240	Neuere Forschungsergebnisse der Großhirnrindenanatomie, mit besonderer Berücksichtigung anthropologischer Fragen	Quantitative data on the size of cortical areas in different human races and brains of mentally disabled patients
Brodmann K (1914) Stuttgart: Enke. Pp 85-426	*Physiologie des Gehirns*. In: F. Krause (Ed.) Die allgemeine Chirurgie der Gehirnkrankheiten. Erster Teil, zweiter Abschnitt.	Textbook-like article on particularly the anatomy of the human brain including some functional considerations

Supplementary figures

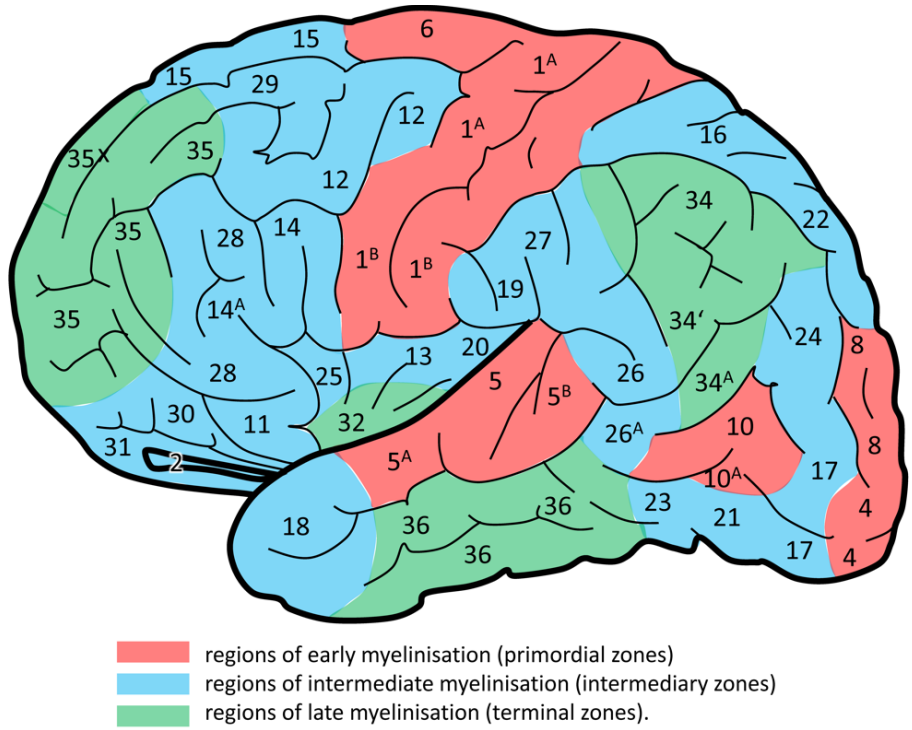
Supplementary figure 1: **A** Joseph Jules Dejerine (1849-1917) and Augusta Dejerine-Klumpke (1859-1927), **B** Wilhelm Maximilian Wundt (1832-1920), **C** Paul Flechsig (1847-1929), **D** Friedrich Alfred Krupp (1854-1902), **E** Margarethe Krupp (1854-1931), **F** Gustav Krupp von Bohlen und Halbach (1870-1950), **G** Bertha Krupp von Bohlen und Halbach (1886-1957).

Supplementary figure 2: **A** Ernst Haeckel (1834-1919). **B** Sea squirts. Drawings from Haeckel E (1899-1904) Kunstformen der Natur, Tafel 85. Leipzig, Bibliographisches Institut. **C** Painting (1909) of the Neuroanatomist Ludwig Edinger by Lovis Corinth. **D** Alois Alzheimer (1864-1915).

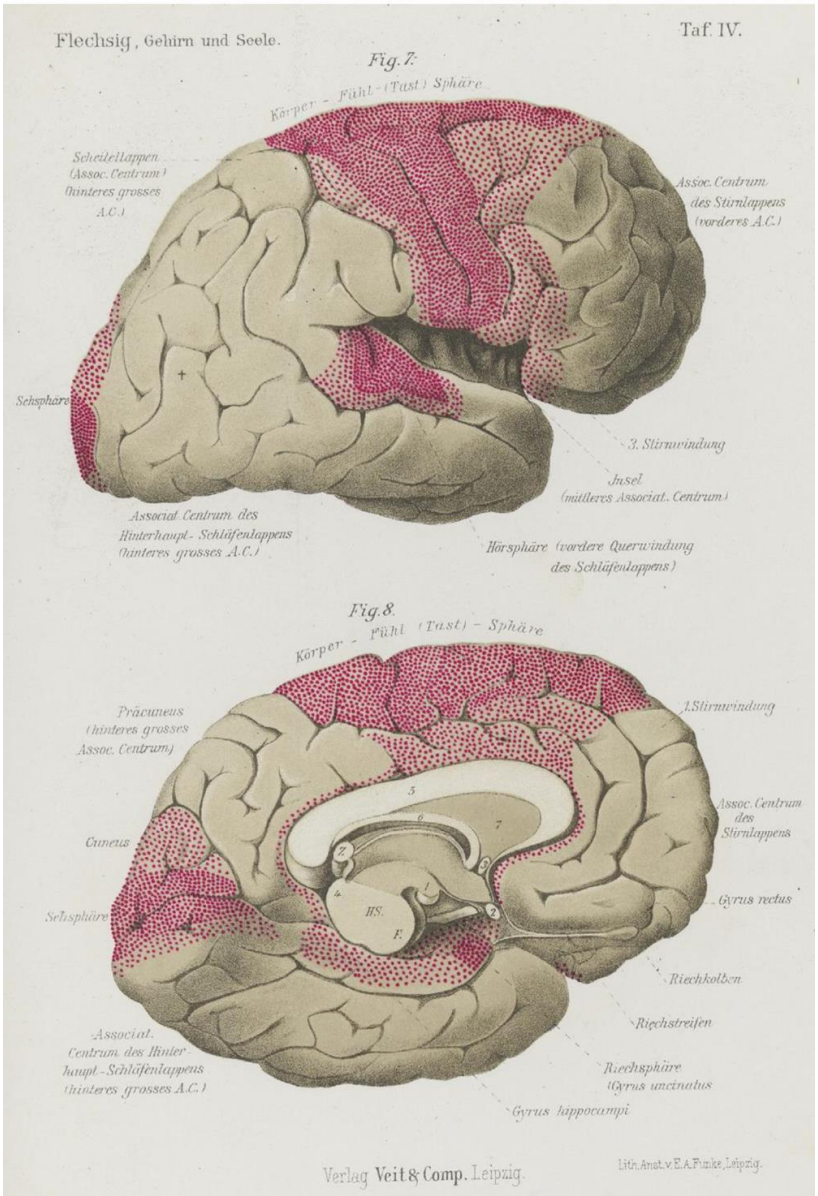
Supplementary figure 3: Homologous heterogenetical regions and exemplarily selected homogenetical areas labeled on Brodmann's map of the **A** human (Brodmann 1910, 1914), **B** cercopithecus (Brodmann 1906), **C** *Lemur niger* (Brodmann 1906, 1912) and **D** hedgehog (Brodmann 1909, 1912) cortex. Brodmann shows a progressive differentiation into primary motor and premotor cortex compared with the poorly differentiated motor region of the hedgehog. An even greater progressive differentiation from one into 8 areas can be seen in the parietal lobe. Also note the much larger heterogenetical cortex of the hedgehog compared with human and non-human primates. It demonstrates a progressive de-differentiation of the paleocortex in higher primates.



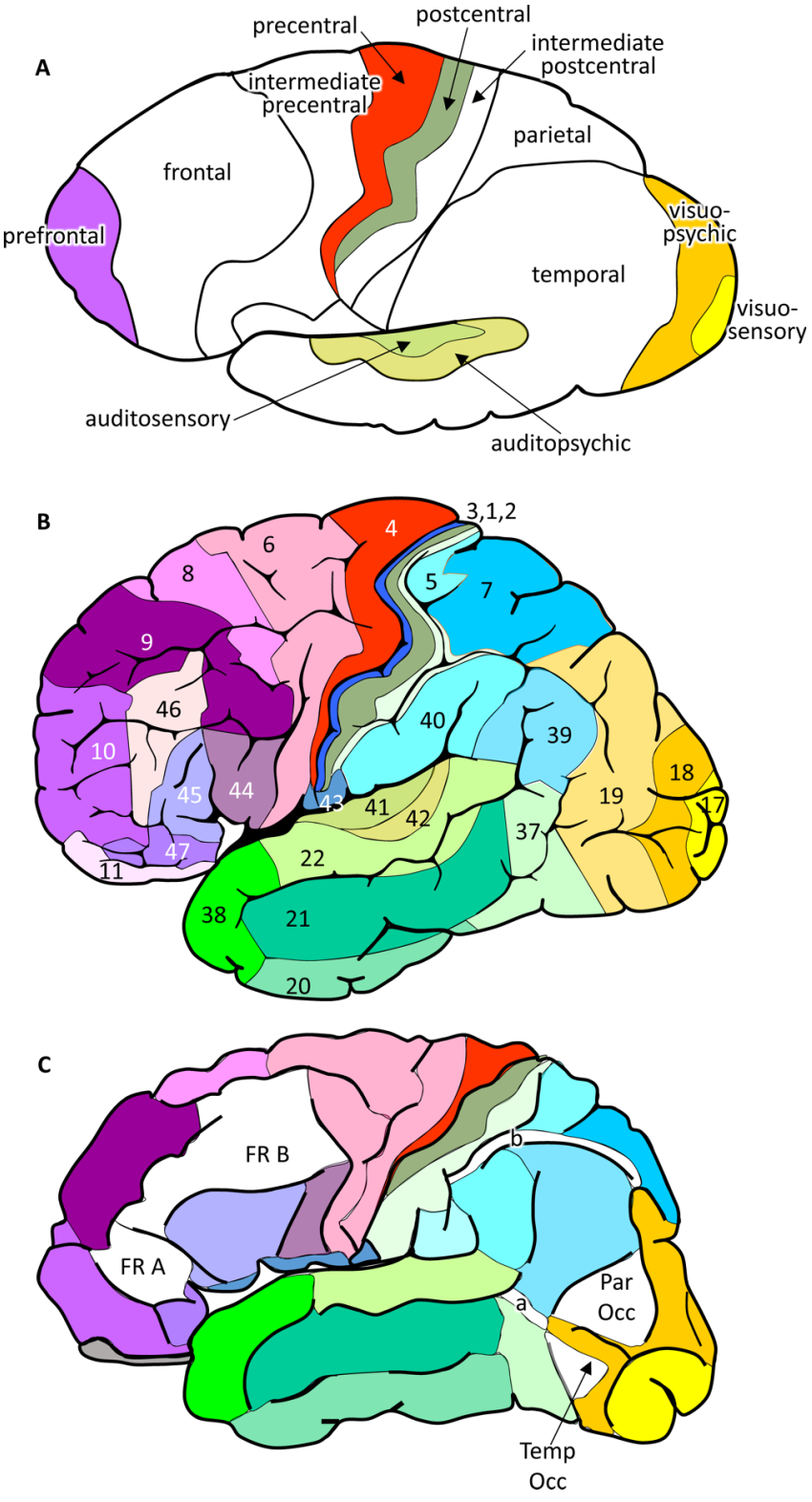
Supplementary figure 4: Myelogenesis in the human cerebral cortex. A later version provided by Flechsig (1901) is shown here. Regions of the earliest myelinating primordial zone show the myelinisation at birth. Myelinisation starts in the newborn in regions of the intermediary zone. Myelinisation does not start in the regions of the terminal zone before completion of the first postnatal month. Arabic numerals indicate cortical areas according to the beginning of myelinisation (1 earliest, 36 latest). No borders of these areas could be determined.



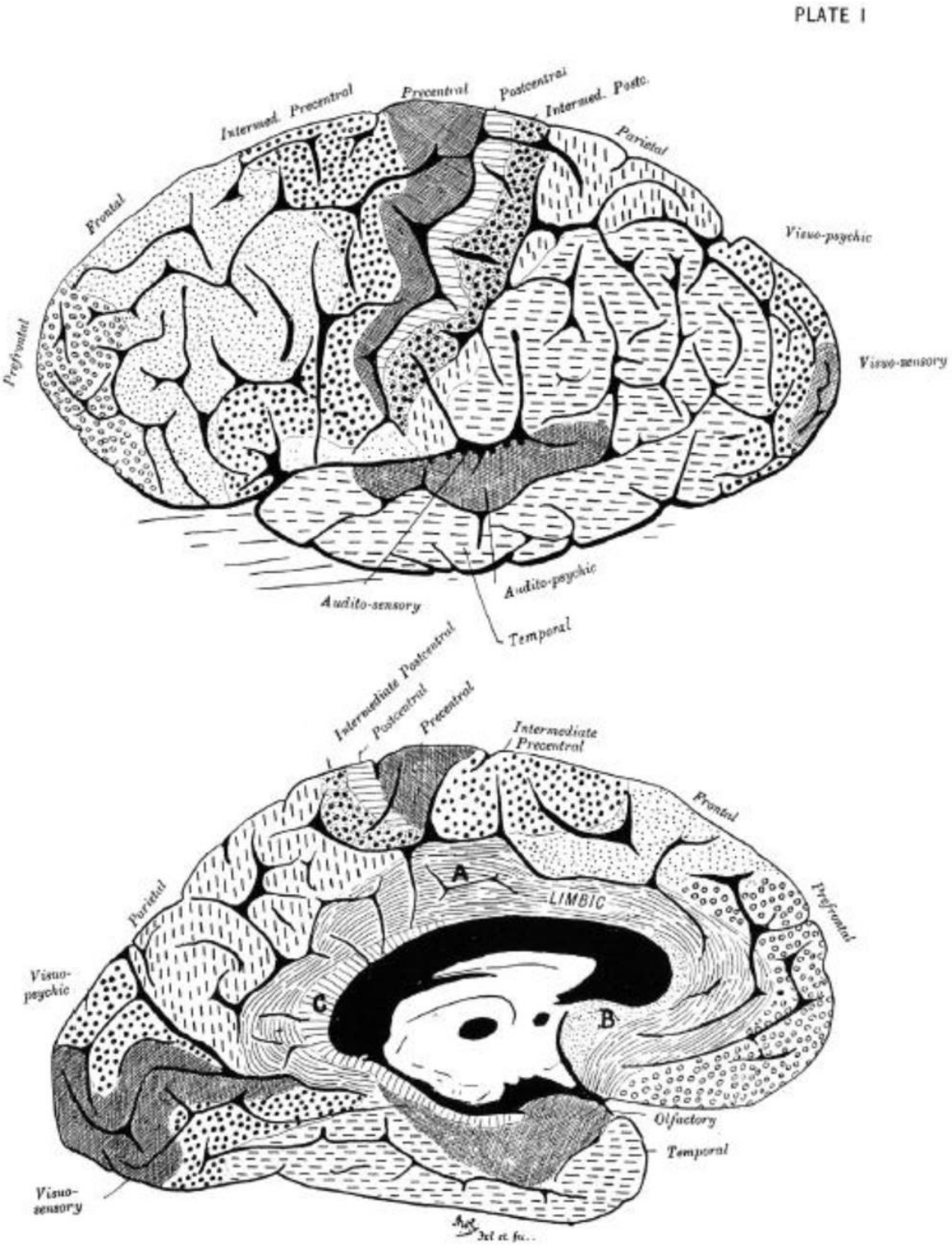
Supplementary figure 5: Myelogenesis as described by Flechsig (1896). A densely red-stippled „Körper-Fühl-(Tast) Sphäre“ (sensorial sphere of the body), which covers the extension of the primary motor, premotor (BA4 and BA6), and the primary sensory areas (BA3,1,2) of Brodmann, and a densely and less densely stippled „Sehsphäre“ (visual sphere) are labelled. The visual sphere of the body was further subdivided by Flechsig into a densely stippled visuosensory (primary visual cortex; BA17 of Brodmann) and a surrounding less densely stippled visuo-psychic region (secondary visual cortex; BA18 of Brodmann). The primary auditory cortex (BA41 of Brodmann; densely stippled) and the secondary auditory cortex (BA42 of Brodmann; less densely stippled) are registered as early myelinating regions. All other regionsd in the „Hörsphäre Querwindung des Schläfenlappens“ (auditory sphere of the anterior transverse gyrus of the temporal lobe). Also labelled are the cingulate and hippocampal gyrus as well as the „Riechsphäre“ (olfactory sphere). All other cortical regions have been identified as late myelinating association centers of the frontal, parietal, insular, temporal and occipital lobes. Flechsig considerably modified this scheme in later publications (see Suppl. Fig.4).



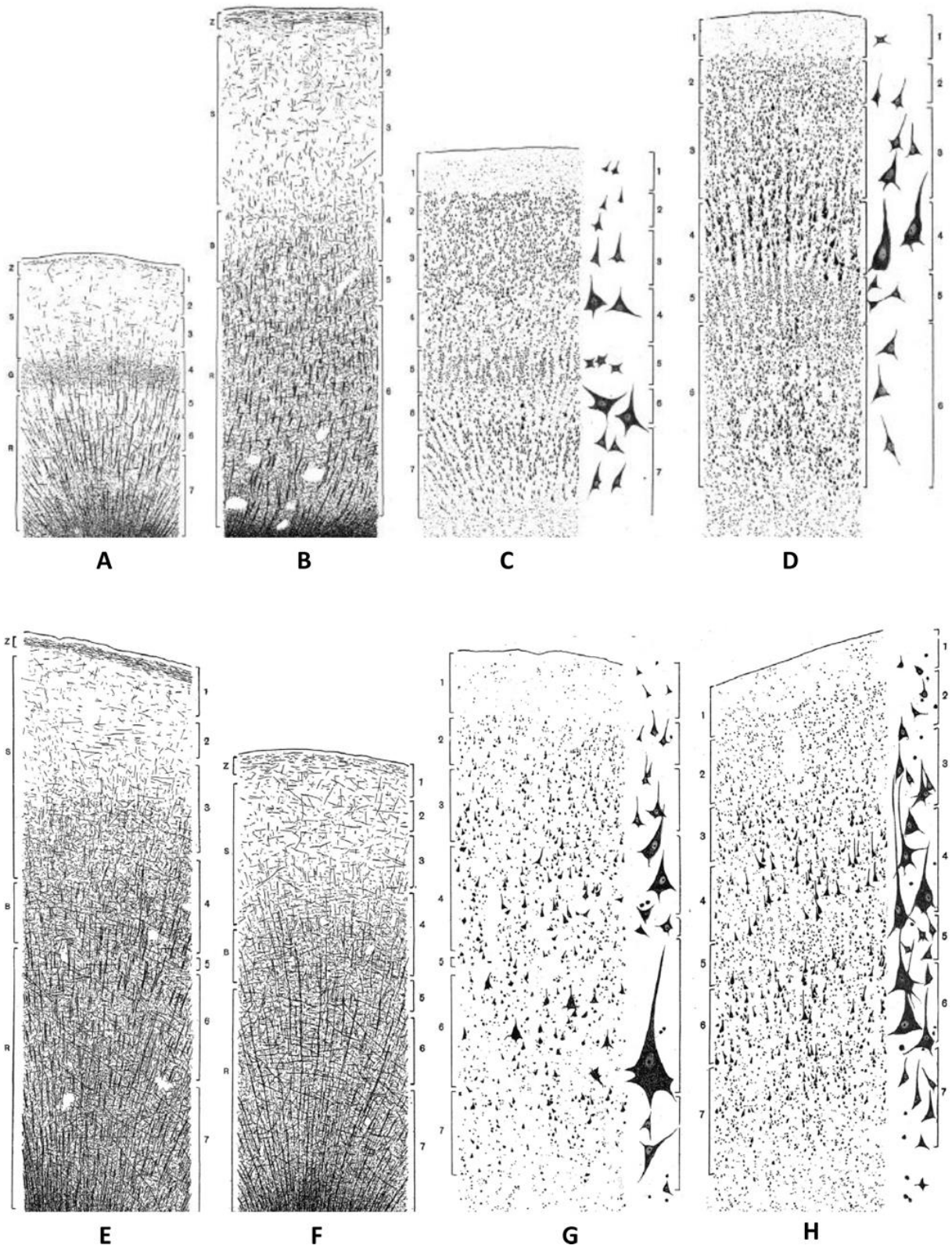
Supplementary figure 6: Lateral views of the brain maps of Campbell (**A** modified after Campbell 1905), Brodmann (**B** modified after Brodmann 1909), and Elliot Smith (**C** modified after Elliot Smith 1907). Comparable parcellations compared to Brodmann's map are labelled by the same colors. Note the high degree of comparability between the maps of Brodmann and Elliot Smith with the exception of higher visual and multimodal association areas in the frontal lobe.



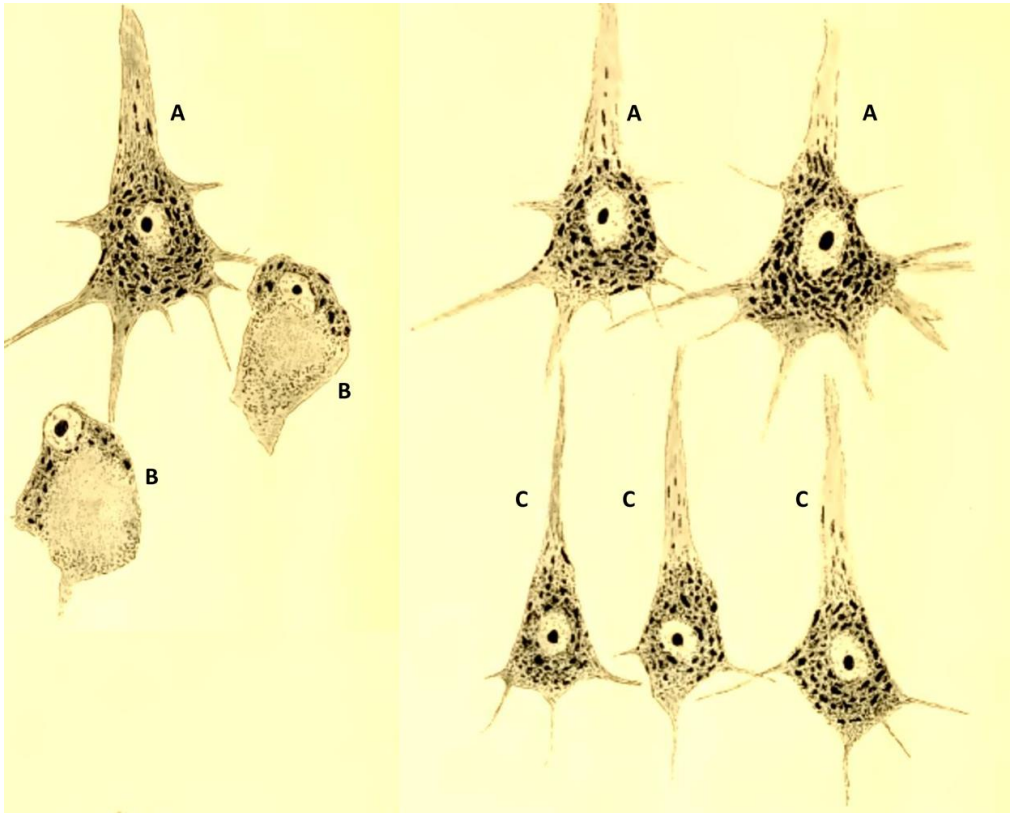
Supplementary figure 7: Maps of the entire cerebral cortex of Campbell (1905). Campbell's regions and Brodmanns areas:. A ~ posterior part of BA24+ BA23, Audito-sensory BA41, Audito-psychic ~ BA42+BA22, B ~ BA25, C ~ BA27, BA29-30, Frontal ~ BA8+BA9, Intermed. Postcentral ~ BA2, Intermed. Precentral ~ BA6, Limbic ~ anerior part of BA 24+BA32, Parietal ~ BA5+BA7+BA31, Postcentral ~ BA3+BA1, Prefrontal ~ BA10-12, Precentral ~ BA4, Temporal ~ BA 20-21+BA38-40, Visuo-psychic ~ BA18+BA19, Visuo-sensory ~ BA17.



Supplementary figure 8: Myeloarchitecture (**A, B, E, F**) and cytoarchitecture (**C, D, G, H**) of the visuosensory (**A, C**), visuopsychic (**B, D**), precentral (**E, G**), and postcentral (**F, H**) areas of Campbell. **A** and **B** from plate X, **C** and **D** from plate XI, **E** from plate III, **F** from plate V, **G** from plate III and **H** from plate VI in Campbell (1905).



Supplementary figure 9: **A** Betz giant pyramidal cells in layer V of the human primary motor cortex. **B** Retrograde reaction (partial disappearance of Nissl-bodies [chromatolysis] and dislocation of the cell nucleus to the periphery of the cell body as sign of a beginning cell degeneration) of Betz giant pyramidal cells after amputation of an extremity. **C** Pyramidal cells in layer V of the human primary somatosensory cortex. Composite of parts of Fig. 3 and Fig. 6 of Campbell (1905).



Supplementary figure 10: **A** Effects of electrophysiological stimulations in a lemur brain (modified after Vogt and Vogt 1907), dorsal view. **B** Cytoarchitectonic map of a lemur brain (modified after Brodmann 1908b), lateral view. **C** Effects of electrophysiological stimulations in a cercopithecus brain (Vogt and Vogt 1926). **D** Cytoarchitectonic map of a cercopithecus brain (modified after Brodmann 1905a). Comparable cortical areas are labelled with red (BA4), orange (BA6) and yellow (BA8) in the electrophysiological and cytoarchitectonic maps. The putative frontal eye field is found in the cercopithecid area BA6 (area 8a,b and d of the Vogt nomenclature). Note the somatotopic map (**C**) in BA4 reminding of Penfield's homunculus long before Penfield and Boldrey (1937).