A Review of Edward Flatau's 1894 Atlas of the Human Brain by the Neurologist Sigmund Freud

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Key Words

Human nervous system • Edward Flatau • Sigmund Freud • Gustaf Retzius • Brain atlas • History of neuroanatomy • Neuron theory

Abstract

In 1894, the Polish neurologist Edward Flatau (1868–1932), working in Berlin, published an exquisite photographic atlas of the unfixed human brain, preceding by 2 years *Das Menschenhirn*, the reference work of Gustaf Retzius (1842–1919) in Stockholm. In his early career as a neuroanatomist and neurologist, Sigmund Freud (1856–1939) wrote a review of Flatau's atlas for the *Internationale klinische Rundschau*, which has not been included in the 'Standard Edition of the Complete Psychological Works'. The aim of the present paper is twofold: to document Freud's review, and to revive the largely forgotten atlas of Flatau. The full text of Freud is presented in translation. Further, one element Flatau, Retzius and Freud had in common is discussed: their early role as protagonists and firm supporters of Ramón y Cajal's neuron theory, the cornerstone of modern neuroscience.

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Introduction

The paths of Edward Flatau (1868–1932), the founder of Polish neurology, and Sigmund Freud (1856–1939), the acknowledged father of psychoanalysis, crossed in 1897, while they were both serving on the editorial board of Karger's *Jahresbericht über die Leistungen und Fortschritte auf dem Gebiete von Neurologie und Psychiatrie* ('Annual Report on the Accomplishments and Progress in the Fields of Neurology and Psychiatry'). The general editor of that journal was Emanuel Mendel (1839–1907); the editorial board comprised such eminent brain researchers as Vladimir Bekhterev (1857–1927), Max Bielschowsky (1869–1940), Ludwig Jacobsohn (1863–1941), Siegfried Kalischer (1862–1954), Lazar Minor (1855–1942), Heinrich Obersteiner (1847–1922), Arnold Pick (1851–1924), Bernhard Pollack (1865–1928) and Theodor Ziehen (1862–1950) [1].

From his student years, in the late 1870s, through the 1890s, Freud occupied himself with the histology, anatomy and pathology of the nervous system, before permanently switching to psychology [2]. In 1891, he published his *Critical Study on Aphasia*, a neurology classic [3]. During those 'neurological' years, Freud regularly reviewed neuropsychiatric articles and books for medical journals. Two such reviews concern anatomical works,

immer nur Wenigen zugänglich sein; es dürfte daher einzig und allein die Photographie ein Hilfsmittel von genügender Brauchbarkeit uns zu liefern im Stande sein.

Mit der Vorlage glaubt die Verlagsbuchhandlung den Interessenten nun ein Werk zu bieten, welches die bisherigen, meist schematischen und gezeichneten Abbildungen weitaus an Anwendbarkeit übertrifft.

Herr Dr. FLATAU hat aus seinen zahlreichen Aufnahmen eine Anzahl **formvollendeter, naturtreuer Photographien** des **frischen** (nicht etwa durch Conservierungsflüssigkeiten veränderten) Gehirns und seiner einzelnen Teile zusammengestellt, welche nun einen Ueberblick über die **gesamte Anatomie des menschlichen Gehirns** bietet. Diesem Bilde der äusseren Formen wurde eine Reihe schematischer Abbildungen beigelegt, um das Hauptsächliche der inneren Struktur — **den Faserverlauf** — zu veranschaulichen. In diesen mehrfarbigen Schematen hat der Herausgeber die modernsten, zum Teil umwälzenden Forschungsergebnisse berücksichtigt, so dass der Atlas eine willkommene **Ergänzung** zu jedem **Lehr- und Handbuch** bieten wird, zumal ein erklärender Text für den Faserverlauf das Ganze verbindet.

Der Atlas enthält:

- I. Basis des Gehirns (incl. Gehirngefässe)
- II. Gesamtansicht von oben.
- III. Horizontalschnitt durch das gesamte Gehirn (Blick in die Ventrikel),
- IV. Tieferer Horizontalschnitt (Grosshirnganglien, innere Kapsel u. s. w.),
- V. Eine Hemisphäre von aussen (mit Hirnstamm),
- VI. Frontalschnitt vor der Chiasma,
- VII. Frontalschnitt hinter der Chiasma (Eintritt des Hirnschenkels in das Gehirn),
- VIII. Hirnstamm mit Umgebung (Boden des IV. Ventrikels, Vierhügel, Schlägel, Schweifkern).
- IX. Eine Hemisphäre von der medialen Seite (mit medialem Schnitt durch den Hirnstamm),
- X. Sagittal-Schrägschnitt durch das gesamte Gehirn (Grosshirnganglien, Stabkranz),
- XI. Sagittal-Schrägschnitt (mehr lateral),
- XII. Dreizehn mehrfarbige Schemata (in Lithographie ausgeführt).

Die Reproduction der Photographien ist in Heliogravure erfolgt, und zwar in der bekannten Kunstanstalt von Meisenbach, Riffarth & Co. Die Tafeln dürften daher, wie auch die beiliegende Probe zeigt, in technischer Hinsicht den höchsten Ansprüchen Genüge leisten. — Im Interesse einer möglichst grossen Verbreitung des Atlas, auch in weiteren Kreisen, ist der Preis für denselben überaus mässig, auf nur Mk. 12.— normirt.

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Fig. 1. A kit by the Samuel Karger Verlag in Berlin for the promotion of Flatau's 1894 *Atlas of the Human Brain* (author's archive).

namely, Obersteiner's textbook on the central nervous system [4], and Flatau's atlas of the human brain [5]. These two reviews have not been included in the *Standard Edition of the Complete Psychological Works* [6]. They are listed as works '1887e' and '1894b', respectively, in the *Ausgewählte Bibliographie* by the Freud Museum in Vienna (<http://www.freud-museum.at/cms/online/freud/themen/biblio.htm>).

Flatau was born in Płock, Poland. He graduated from Moscow University in 1892 and worked in Berlin between 1893 and 1899, the year he returned to Warsaw [7, 8]. In 1894, at the age of 26 years, Flatau published his *Atlas of the Human Brain and the Course of Nerve Fibres* [9]. That work (fig. 1), in large quarto (27×36 cm), most likely rep-

resents the first photographic atlas of the human brain in the German language. It appeared in print 2 years prior to the publication in Stockholm of the photographic atlas *Das Menschenhirn* by Gustaf Retzius (1842–1919), perhaps the most outstanding work in macroscopic neuroanatomy of the 19th century [10].

Flatau used whole and dissected human brains, unfixed and only rinsed in water. He applied small diaphragms to effect a better depth of field, and took long-exposure photographs, with exposure times of 20–30 min for uneven surfaces (ventral, dorsal, lateral and medial facies, plates I, II, V and VII), and up to 10 min for flat sections (horizontal, coronal and sagittal, plates III/IV, VI and VIII) [9, 11] (fig. 2). A schematic color chro-

Fig. 2. A sample plate (*Probetafel*) from Flatau's *Atlas of the Human Brain* by Karger, Berlin, left, depicting the ventral cerebral facies (author's archive). Flatau demonstrating his method for macroscopically photographing fresh human brains, right; from a technical article [11] traced from a citation by Pollack [51] (courtesy: Universitätsbibliothek Hamburg).

Fig. 3. The 35-year-old Sigmund Freud in Vienna, left (credit: Sigmund Freud Museum, London). Freud's review [5] of the Flatau atlas, middle (courtesy: Universitätsbibliothek der Medizinischen Universität Wien). The 33-year-old Edward Flatau in Berlin, right (credit: Wikimedia Commons, <http://upload.wikimedia.org>; original photograph traced by Eisenberg [18] in the Berta Lask Archive, Berlin Academy of Arts).

molithograph depicted central brain pathways and connections [9, 12].

The work had been carried out in the laboratory of the Neuropsychiatric Institute of Emanuel Mendel, who also contributed the preface. The atlas was simultaneously published in German, English, French, Polish and Russian [9, 12]. A supplement on microscopy [1] and an inclusive second, revised and enlarged edition [13] were issued 5 years later, including seven additional plates (IX–XV) depicting the cranial nerve nuclei, midbrain, pons, medulla, and spinal cord. Flatau incorporated his 1897 discovery – known as Flatau’s law – that the greater the length of a fiber in the spinal cord, the more eccentrically it is located [14], as well as key findings from his degeneration studies [13]. The supplemental work for the second edition was carried out at the Anatomical Institute of Wilhelm Waldeyer (1836–1921).

With Jacobsohn, Flatau co-authored another classic, the *Handbook of Comparative Anatomy of the Mammalian Central Nervous System* [15]. With Minor, they co-edited a two-volume *Handbook of Neuropathology* [16, 17]. Both texts became indispensable references for their contemporaries and successors [18, 19].

An English translation of Freud’s review [5] follows (fig. 3). The review of Obersteiner’s textbook [4] forms the subject of a separate paper.

The Review by Freud

Dr. Flatau hereby offers physicians and students an atlas of the human brain, which depicts the various full views and some of the most important brain sections in eight plates (11 figures). These plates – from photographs of fresh brain – give an almost three-dimensional impression of the cerebral facies, in clear and characteristic sections, overall deserving to be designated as a superb teaching aid, suitable as a totally reliable reference for both self-study, in the case of not having access to fresh material, and for comparisons at autopsy and the like.

A leading ‘schematic plate’ in this atlas attempts to give an overview of our knowledge on the course of fiber pathways in the central nervous system in 13 multi-colored drawings, incorporating the known accounts of Mendel, Bekhterev and Efinger on this theme, and continuing with the opposing views of Golgi and Ramón [y Cajal] on the structure of the nervous tissue. The 27 text pages are devoted to the explanation of these schematic drawings. The price of the work (12 marks) is minimal if one considers its breadth and beauty. Author and publisher deserve the appreciation of the medical community for this valuable work.

Sigmund Freud

[*Atlas of the Human Brain and the Course of Nerve Fibres*. By Ed. Flatau. With a Foreword by Prof. E. Mendel. S. Karger Verlag, Berlin 1894. (Critical Reviews and Literary Notices.)]

Comment

Photographic versus Drawn Atlases of the Human Brain

The *Iconographie Photographique* [20] by the French neurologist Jules Bernard Luys (1828–1897) constitutes the first photographic atlas of the human brain. Prior to that artistic drawings were used to depict brain structure in standard atlases of the time [21–24]. The advent of the photographic technique, with its acclaimed precision, would eventually secure more impartial, impersonal and authentic reproductions of brain form, deemed by investigators to be more accurate than drawings and engravings [25]. In the words of Koskinas [26], ‘...the hitherto investigations of the brain depicted things schematically and therefore subjectively; if one aims at representing specimens accurately, one makes use of photography; photographic documentation constitutes the most truthful testimony of an exact depiction of nature, as it provides a truly objective image of things as these bear in natural form, size and arrangement.’

The industrious Luys (‘subthalamic nucleus of Luys’) developed an original view of the structural and functional organization of the brain, and contributed to our knowledge of the neuropathological aspects of mental illness [27]. The *Iconographie* [20] was illustrated with 70 plates containing 81 original albumen prints of brain sections (fixed in a chromate-glycerin solution), plus schematic drawings from his hand.

Édouard Brissaud (1852–1909; upturned ‘sulcus of Brissaud’ on the superolateral convexity of the superior parietal area) authored the *Anatomie du cerveau de l’homme* accompanied by a splendid atlas with 43 plates [22], drawn by himself in what appears to be a fine art; that prodigious work is still relevant today [28].

The pinnacle of photographic brain atlases of the late 19th century is considered to be the 167-page text volume and the 96-collotype plate volume in large quarto (30×39 cm) of Retzius [10]. The massive opus of scholarship was issued in a limited run of 500 sets. The text was organized in three parts, dealing with the development of the human brain, the morphology of the human brain, and the surface pattern of cortical sulci and gyri in 100 adult hemispheres (35 male right, 40 male left, 12 female right, and 13 female left). The plates comprised 486 drawings (by Sigrid Andersson, Hilma Bundsen, Gustaf Wennman and Ebba Flodman) and 327 directly reproduced photolithographs in natural size; about one third of the plates covered prenatal development (2–9 months of gestation), and the remaining two thirds depicted the adult macroscopic

brain structure, with emphasis on individual variations. Specimens were fixed in chrome-osmium-acetic acid, potassium bichromate or formalin. Retzius clarified some of the more difficult problems of cerebral morphology. The wealth of the illustrations and their detailed description rendered *Das Menschenhirn* the best work ever offered until then [29], and also addressed age and gender differences. Retzius made some new discoveries, such as the saccular eminence on the tuber cinereum, the homologue of the saccus vasculosus of lower vertebrates, the relations of the amygdala, and new gyri in the rhinencephalon, the gyrus ambiens and semilunaris, and the fasciolar gyrus. He paid homage to his late father, anatomy professor Anders Retzius (1796–1860) of Karolinska Institutet, by dedicating *Das Menschenhirn* in commemoration of the latter's 100th birthday, and by naming the rudimentary intralimbic gyri after him ('gyri of Anders Retzius').

Freud, Neurology and the Neuron Doctrine

Freud made substantial contributions to basic neuroscience and clinical neurology [2, 30, 31]. He carried out pioneering neuroanatomical studies, using the Weigert method, on the connections of the superior olivary nuclei, on the origin and course of the eighth cranial nerve, and on the relations of the restiform body, as well as neuropathological studies on acute polyneuritis, aphasia, and infantile cerebral diplegia. He suggested, decades ahead of his time, that the trigeminal nucleus might be involved in migraine, also ascribing an important role to the meninges and the innervation of blood vessels [30]. With his histological studies on the spinal ganglia and spinal cord of the lamprey and the structure of nerve cells and fibers in the river crayfish, Freud became one of the early protagonists of the neuron theory [2, 32, 33]. He demonstrated the fibrillary structure of the protoplasm and documented the phenomenon of nuclear rotation in neurons [34]. Moreover, in his 1895 *Project for a Scientific Psychology* [6], Freud proposed the term *Contactschranke* ('contact barriers') to denote what Charles S. Sherrington (1857–1952) would term 'synapses' 2 years later at the suggestion of the Euripides scholar Arthur W. Verrall (1851–1912) of Trinity College [35]. The actual visualization of such 'barriers' and definite proof of the neuron theory would be established half a century later by means of the electron microscope [33, 36].

The value of Flatau's atlas reaches beyond gross morphology. It firmly supports Ramón y Cajal's *neuronismo*. Flatau had joined the Anatomical Institute only 2 years after Waldeyer, his director, had introduced the term *neuron* to denote the nerve or ganglion cell [37]. The word

'neuron' (Greek νεῦρον = nerve) first appears in Homer [38]. Waldeyer [37] adopted the term 'neuron' (Greek νευρών = nerve cell) and popularized the neuron theory, largely based on the landmark discoveries of Ramón y Cajal [39–41], and the substantial contributions of Forel, van Gehuchten, Gowers, His, Kölliker, von Lenhossék, Nansen, Nissl, and others [33, 36, 42–44]. Studying a wide variety of invertebrate and vertebrate species, Retzius had also provided evidence that helped establish the neuron theory [45, 46].

In the first paragraph of his atlas, Flatau states: 'The function of the dendrons is not as yet positively known, some authors (Ramón) being of the opinion that they are nervous; others (Golgi) believe them to have a trophic influence upon the cells. A nerve cell, with its nerve fiber process and the terminal branches of the latter, forms a *nerve unit* or '*neuron*' of Waldeyer. The nervous system is made up of an immense number of those independent units, communicating with and influencing one another by contact' [9, 12].

Flatau took a clear stance for neuronism in a subsequent review [47]. He further provided experimental data for the unity of the neuron using the Nissl method, by cutting the oculomotor nerve and detecting secondary changes in the oculomotor nucleus [48]. Fully comprehending the technical basis of brain fixation procedures [49], staining methods [50, 51] and the caprices of silver impregnation [52], Flatau analyzed secondary degeneration after limb amputation in rodents, rabbits and dogs, as well as the effects of toxins, by using the Golgi and Marchi methods [16, 17, 53, 54].

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