

The school of Wernicke

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ABSTRACT

Introduction. Carl Wernicke (1848-1905) was the master and mentor of numerous physicians interested in human behaviour from an organicist perspective, initially as the director of the Breslau Psychiatric Clinic and later of the Psychiatry and Neurology Clinic of the University of Halle. This study aims to identify Wernicke's most relevant disciples and describe their scientific and medical contributions.

Development. The article describes the main members of Wernicke's school: Karl Freund (1862-1932), Heinrich Lissauer (1861-1891), Heinrich Sachs (1863-1928), Ludwig Mann (1866-1936), Karl Bonhoeffer (1868-1948), Hugo Liepmann (1863-1925), Karl Heilbronner (1869-1914), Otfried Foerster (1873-1941), Kurt Goldstein (1878-1965), and Karl Kleist (1879-1960).

Conclusions. Wernicke's scientific interests, halfway between neurology and psychiatry, influenced the fields studied by his disciples. Freund, Lissauer, Liepmann, and Heilbronner developed connectionist models of the brain to explain agnosia, apraxia, and aphasia. Sachs and Foerster studied the anatomy of the brain, while Bonhoeffer and Kleist dedicated their work to psychiatry.

KEYWORDS

Carl Wernicke, neurology, neuroanatomy, psychiatry, connectionist model, mental illness

Introduction

In the 1860s, the Hospice de la Salpêtrière (Paris) and the National Hospital for Nervous Disease (London) became international references in the field of neuroscience.¹

The reputation of the Salpêtrière school was largely derived from the work of Jean-Martin Charcot (1825-1893). Charcot, an emperor at the Salpêtrière, instructed or influenced numerous neurologists, psychiatrists, and psychologists: Benjamin Ball (1833-1893), Leopold Ordenstein (1835-1902), Désiré-Magloire Bourneville (1840-1909), Fulgence Raymond

(1844-1910), Albert Pitres (1848-1928), Paul Richer (1849-1933), Paul Regnard (1850-1927), Charles Féré (1852-1907), Gilbert Ballet (1853-1916), Eugen Bleuler (1857-1939), Alfred Binet (1857-1911), Georges Gilles de la Tourette (1857-1904), Pierre Janet (1859-1947), Achille Souques (1860-1944), Joseph Babinski (1857-1932), and Pierre Marie (1853-1940).

Unlike the training model at the Salpêtrière, the prestige of the National Hospital for Nervous Disease was based on the talents of a series of relevant figures, who collectively developed an internationally recognised body of knowledge. Among these, we may mention Charles Edouard Brown-Séquard (1817-1894), John



Figure 1. University of Breslau. Main building (19th century).

Hughlings Jackson (1835-1911), John Russell Reynolds (1828-1896), Henry Charlton Bastian (1837-1915), William Gowers (1845-1915), and David Ferrier (1843-1928).

The model at the Salpêtrière school, revolving around a charismatic figure of considerable reputation, who was able to attract and train young disciples, was not exclusive to this French institution. The Breslau Psychiatric Clinic (Figure 1) and the figure of Carl Wernicke (1848-1905; Figure 2) are another clear example.

Carl Wernicke was born in Tarnowitz (today, Tarnowskie Góry) in the Silesian Highlands, and studied medicine at the University of Breslau.² After graduating, he worked as an assistant physician in Carl Foerster's (1825-1902) neurology department, and subsequently as an army surgeon during the Franco-Prussian War (1870-1871). The conflict ended on

10 May 1871, and he began working as a physician at the Breslau Psychiatric Clinic, which at the time was under the directorship of Heinrich Neumann (1814-1884). In 1874, he published his book *Der aphasische Symptomencomplex: eine psychologische Studie auf anatomischer Basis* ("The aphasia symptom-complex: a psychological study on an anatomical basis"),³ a key work on language alterations (Figure 3). Between 1875 and 1878, he worked at the neurology and psychiatry department at the Charité hospital in Berlin. Subsequently, still in Berlin, he began working in private practice as a specialist in nervous diseases. During his time in Berlin, Wernicke wrote his *Lehrbuch der Gehirnkrankheiten für Ärzte und Studierende* ("Textbook of diseases of the brain for physicians and students"), published between 1881 and 1883, in which he describes the anatomy, pathology, and ontogenesis of the brain. In 1885, he replaced Neumann as director



Figure 2. Carl Wernicke (1848-1905).

of the Breslau Psychiatric Clinic, remaining there until 1904. That year, he transferred to the University of Halle to direct the Psychiatric and Neurological Clinic. He died on 15 June 1905 following a bicycle accident.

Wernicke was master and mentor to a whole generation of professionals interested in human behaviour from an organicist perspective. Starting from Wilhelm Griesinger's (1817-1868) premise that "all mental illness is disease of the brain" and Theodor Meynert's (1833-1892) associationist model of the brain, Wernicke proposed a functional model structured around different levels of cognitive processing (psychological description), brain areas and connections associated with each stage of processing (neurological description), and specific symptoms secondary to

associated brain lesions (clinical description).⁴ This way of understanding the brain was largely accepted by the international scientific community, although it also received harsh criticism. The psychiatrist Karl Jaspers⁵ (1883-1969) considered Wernicke to be engaging in a "brain mythology" (*Hirnmythologen*) that explained human behaviour by linking psychological disorders and brain regions, establishing generalisations that went beyond fact. The aim of this study is not to analyse the figure of Wernicke, but rather to identify the most relevant of his disciples (Figure 4).^A To this end, we conducted a literature search of the PubMed and Google Scholar databases and consulted works on the history of neurology and related sciences.

Wernicke's disciples

Karl Freund (1862-1932) was one of Wernicke's first assistants in Breslau (between 1885 and 1888).⁶ In 1887, he observed the symptom complex that is now known as Korsakov syndrome (years before Sergei Korsakov). A year later, he described the case of a patient who could recognise objects but was unable to name them, naming the disorder optic aphasia.⁷ He argued that the anatomical cause of the disorder must be an interhemispheric disconnection. The post mortem examination showed lesions to the splenium of the corpus callosum.

The same year that Freund described optic aphasia, Heinrich Lissauer (1861-1891), Wernicke's assistant between 1888 and 1891, proposed a stage model of object recognition.⁸ In 1890, he published the article "Ein Fall von Seelenblindheit nebst einem Beitrage zur Theorie derselben" ("A case of mind-blindness and a contribution towards a theoretical explanation"),⁹ analysing the perceptual alterations in the patient Mr Gottlieb from the perspective of his model of visual recognition. According to Lissauer, the process of recognition (*wiedererkennen*) involves a perceptual stage and a second associative stage. Alterations in the perceptual stage result in what Lissauer terms *apperceptiven Form der Seelenblindheit* (the apperceptive form of mind-blindness, caused

^AIn some cases, they started working with Wernicke as *Volontärärzte* (unpaid volunteer physicians) before becoming his assistants.

^BThe term apperceptive soul blindness (*apperceptive Seelenblindheit*) corresponds to what is known today as apperceptive agnosia.

by involvement of perceptual mechanisms or the connection between sensation and perception). He refers to alterations in the associative stage as *assoziativen Form der Seelenblindheit* (the associative form of mind-blindness, caused by disconnection between perception and the corresponding stored conceptual associations). The associative stage underpins the ability to access the meaning and nature of a visual object.

In 1892, Heinrich Sachs (1863-1928), assistant to Wernicke and a colleague of Freund and Lissauer, published the first atlas describing the connections of the occipital lobe of the human brain.¹⁰ Sachs observed that occipital fibres were organised in four layers (*Schichten*): 1) corpus callosum (*forceps corporis callosi*); 2) projection fibres (*stratum sagittale internum*); 3) long association fibres (*stratum sagittale externum*); and 4) short association fibres (*stratum proprium corticis*). In his atlas, he notes that:

[...] a superficial softening within this region can, depending on its depth, isolate the stratum sagittale externum or damage both the stratum sagittale externum and the stratum internum. This can cause transcortical syndromes such as optic aphasia (Freund) or apperceptive soul blindness^B (Lissauer) due to an interruption of the connections between visual and auditory centres.^{10(p192)}

Wernicke succeeded Neumann as director of the Breslau Psychiatric Clinic in 1885. Four years later, Ludwig Mann (1866-1936), Wernicke's assistant between 1889 and 1896, was appointed chief physician of the clinic's outpatient service. In 1889, Wernicke described the characteristic posture and gait of hemiplegia, but charged Mann with writing an in-depth analysis of what we now know as the Wernicke-Mann position.¹¹ After completing his training under Wernicke, Mann became interested in the applications of electricity for the diagnosis and treatment of diseases of the brain.¹²

Karl Bonhoeffer (1868-1948) (Figure 5A) was an assistant to Wernicke between 1893 and 1898. In 1904, he became director of the Breslau Psychiatry Clinic. Eight years later, in 1912, he transferred to Berlin, where he led the Charité hospital's psychiatry and neurology department until 1938.^{13,14} Bonhoeffer was the leading figure in the Berlin school of psychiatry of the early 20th century. In 1908, he published *Zur Frage der Klassifikation der symptomatischen Psychosen* ("On the question of the classification of symptomatic

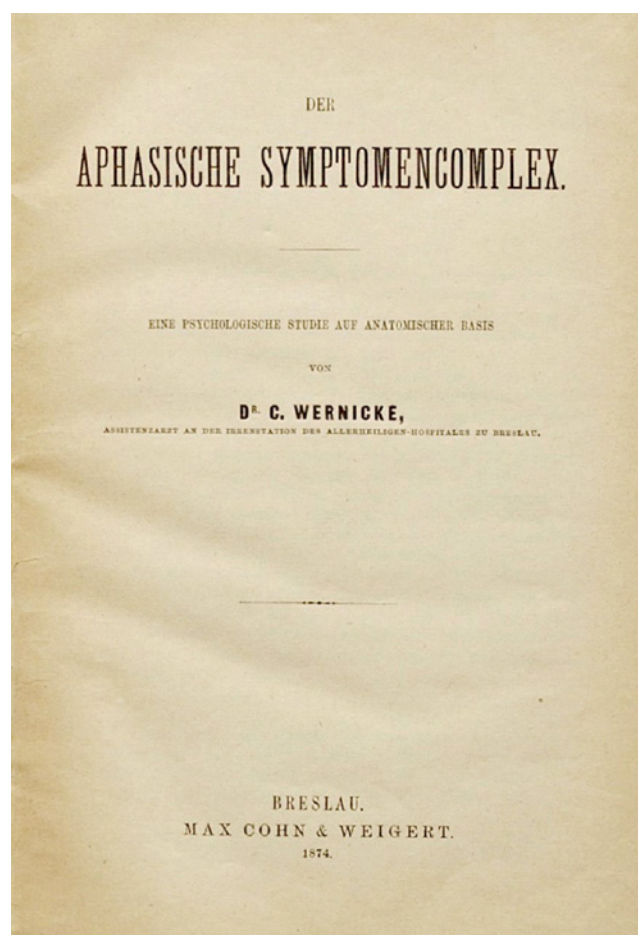


Figure 3. Title page of the book *Der aphasische Symptomencomplex: eine psychologische Studie auf anatomischer Basis* (1874).

psychoses”),¹⁵ in which he described and classified symptomatic psychoses, distinguishing between exogenous and endogenous psychoses. This work provided evidence of the existence of a limited number of psychopathological syndromes, for a great variety of somatic disorders; therefore, they are aetiologically nonspecific. His findings contradict Emil Kraepelin's (1856-1926) argument that psychiatric phenotypes

¹⁵Quadfasel was director of the Boston Veterans Administration Medical Center (United States) between 1947 and 1963. His staff included Harold Goodglass (1920-2002), Edith Kaplan (1924-2009), and Norman Geschwind (1926-1984), who played a crucial role in the development of neuropsychology and behavioural neurology in the latter half of the 20th century.

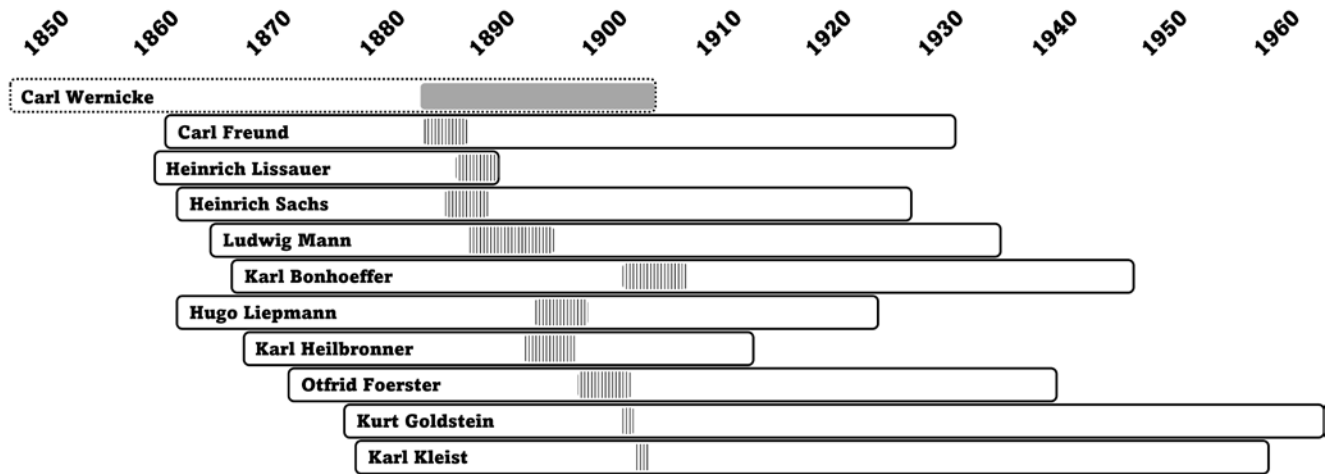


Figure 4. Timeline showing the lifetimes of Wernicke's main disciples. The shaded sections for each figure show the years they trained under Wernicke. The section in grey for Wernicke's timeline corresponds to the years in which he acted as a mentor.

signal specific pathological entities. Bonhoeffer's collaborators include Hans-Gerhard Creutzfeldt (1885-1964), Arthur Kronfeld (1886-1941), Erwin Straus (1891-1975), Paul Jossman (1891-1978), Jürg Zutt (1893-1980), Franz Josef Kallmann (1897-1965), Lothar Kalinowski (1899-1992), and Alfred Quadfasel (1902-1981).^c

Hugo Liepmann (1863-1925) (Figure 5B) was assistant to Wernicke from 1895 to 1899. His scientific interests spanned several fields, such as agnosia and the localisation of brain functions, although his best known contributions are on the subject of apraxia.¹⁶ In 1907, he synthesised the clinical, anatomical, and pathological aspects of this gestural disorder, distinguishing between three types¹⁷: ideatory apraxia (*ideatorische Apraxie*), ideokinetic apraxia (*ideokinetische Apraxie*), and limb-kinetic apraxia (*gliedkinetische Apraxie*). Karl Heilbronner (1869-1914) (Figure 5C), a colleague of Liepmann and assistant to

Wernicke between 1894 and 1898, was also interested in apraxias. In 1905, he published his article "Zur Frage der motorischen Asymbolie (Apraxie)" ("On the question of motor asymbolia [apraxia]"),¹⁸ in which he classified apraxias into three subtypes: cortical apraxia (*kortikale Apraxie*), transcortical apraxia (*transkortikale Apraxie*), and conduction apraxia (*Leitungsapraxie*).

The most brilliant of Wernicke's disciples was probably Otfrid Foerster (1873-1941). After completing his medical studies, and following the recommendation of Wernicke, he travelled to Paris in 1897 to train with Joseph Jules Dejerine (1849-1917), Pierre Marie, and Joseph Babinski. In 1899, he returned to Breslau, working as Wernicke's assistant until 1903. In 1911, he founded the neurology department of the University of Breslau, the first of its type in Germany. During the First World War, he became chief physician of the neurology department at the Military Citadel Hospital in Breslau. In the 1930s, the Nazi regime restricted his professional



Figure 5. A) Karl Bonhoeffer (1868-1948). B) Hugo Liepmann (1863-1925). C) Karl Heilbronner (1869-1914).

activities due to his relationship with Russia (he had been Lenin's personal physician) and his wife's Jewish ancestry.^{19,20}

Foerster was the most important German physician of the first half of the 20th century, and Breslau became a mecca for numerous neurologists and neurosurgeons.^{21,22} As a neurologist, his contributions include the concept of rhizotomy as a cure for spasticity, anterolateral cordotomy to relieve pain, the hyperventilation test for epilepsy, and the first electrocorticography study of a brain tumour. As a neurosurgeon, he was able to resect intraventricular, pituitary, and quadrigeminal cistern tumours, and was a pioneer of epilepsy surgery under local anaesthesia. In the interwar period, Breslau received professionals from numerous countries who sought to learn under Foerster: Herbert McLean Evans (1882-1971), Wilder Penfield (1891-1976), Percival Bailey (1892-1973), Robert Wartenberg (1887-1956), Harold Leeming

Sheehan (1900-1988), and Paul Bucy (1904-1993). He had a small number of German disciples, including Ludwig Guttmann (1899-1980), who worked with him in two periods: 1924-1928 and 1929-1933.

Kurt Goldstein (1878-1965) was one of Wernicke's last disciples in Breslau. The two worked together for just a few months, in 1903. Early in his career, Goldstein adopted Wernicke's associationist model, seeking to identify centres and pathways of interconnection to explain the different symptom complexes derived from brain lesions. However, as he gained experience, he began to question the localisation hypothesis, as well as Wernicke's working model, becoming a proponent of the holistic view of brain function. One of the arguments he employed was the so-called problem of recovery, or evidence of the brain's capacity to re-establish lost or altered functions. The fact that many patients were able, to an extent, to compensate for lost brain functions indicated that one brain region

was able to take on the function of another. This view collides head-on with the mechanistic conception of the nervous system, as well as undermining the principle of strict localisation, an essential pillar of the associationist theories popularised by Wernicke.²³ Wernicke left the Breslau Psychiatric Clinic for the University of Halle in 1904. At this German institution, he was a mentor to Karl Kleist (1879-1960). Like Wernicke, Kleist defended a neurobiological (organic) view of psychiatry, and attempted to classify psychiatric disorders according to dysfunction in localised brain regions.²⁴ His efforts to localise psychiatric symptoms in the brain were crystallised in the publication in 1934 of his monumental work *Gehirnpathologie: vornehmlich auf Grund der Kriegserfahrungen* ("Cerebral pathology mainly due to war experiences").^{25,26}

Conclusion

The body of knowledge developed by the school of Wernicke is structured around two central ideas: 1) mental illness is derived from organic alterations in the brain; and 2) the functional organisation of the brain is based around centres, connections, and distributed systems (associationist/connectionist model). Wernicke understands the brain as a grouping of specialised anatomical centres with specialised functions, which are interconnected to enable the flow of information between centres. According to this conceptual framework, all mental illness can be predicted based on the understanding of how centres are destroyed or information flow between them is interrupted. While in the late 19th century Wernicke was more concerned with mental illnesses that escape anatomical pathological description than with those showing a clear relationship between brain lesion and symptom, he never completely abandoned his organicist view of mental illness.

Wernicke's scientific interests, halfway between neurology and psychiatry, influenced the fields studied by his disciples. His organicist view of mental illness led Freund, Lissauer, Liepmann, and Heilbronner to develop connectionist models to explain agnosia, apraxia, and aphasia. Other disciples, such as Sachs and Foerster, studied the anatomy of the brain by staining axons and dendrites, a technique Lissauer imported to Breslau after studying with Carl Weigert (1845-1904) in Leipzig. With regard to the school's interest in psychiatry, the contributions of Bonhoeffer and

Kleist are noteworthy. The latter interpreted clinical observations from a neuropathological viewpoint, following the tradition that began with Griesinger and was subsequently continued by Wernicke. Bonhoeffer, who was rather more critical of this organicist conception, considered anatomy (and, by extension, neurology) to be subordinate to the needs of psychiatry.

Wernicke worked with multiple assistants during his years at the Breslau Psychiatric Clinic (and his brief stint at the University of Halle). This study addresses the most relevant of his students and their scientific contributions. However, Wernicke's school is not limited to these figures; other disciples include Paul Kemmler (1865-1929), Ernst Storch (1866-1916), Frank Kramer (1878-1967), Paul Schröder (1873-1941), Robert Gaupp (1870-1953), and Edmund Forster (1878-1933).

Conflicts of interest

The authors have no conflicts of interest to declare.

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