FROM NEUROLOGY TO PSYCHOANALYSIS

SIGMUND FREUD'S NEUROLOGICAL DRAWINGS AND DIAGRAMS OF THE MIND

LYNN GAMWELL MARK SOLMS

2006

This exhibition and publication were produced by the Binghamton University Art Museum in cooperation with the Arnold Pfeffer Center for Neuro-Psychoanalysis at the New York Psychoanalytic Institute and the American Psychoanalytic Association.

From

NEUROLOGY

to

PSYCHOANALYSIS

SIGMUND FREUD IN 1891

From
NEUROLOGY
to
PSYCHOANALYSIS

SIGMUND FREUD'S NEUROLOGICAL DRAWINGS AND DIAGRAMS OF THE MIND

LYNN GAMWELL MARK SOLMS

BINGHAMTON UNIVERSITY ART MUSEUM
STATE UNIVERSITY OF NEW YORK
2006

This publication was produced on the occasion of an exhibition of the same title, which was curated by Lynn Gamwell, director, Binghamton University Art Museum. The exhibition was shown at:

New York Academy of Medicine
May 6 - August 26, 2006

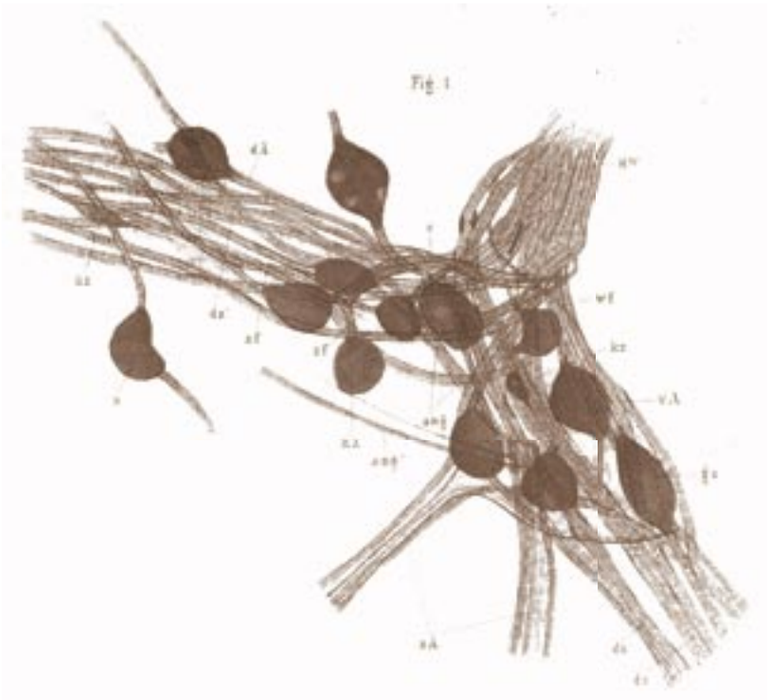
Binghamton University Art Museum, State University of New York
Sept. 8 - Oct. 20, 2006

Copyright © 2006 by the State University of New York at Binghamtom

Edited by Lynn Gamwell
Designed by David Skyrca
Translations by Mark Solms
Produced by Binghamton University Publications
Printed by Midstate Litho, Endicott, New York

All images in this publication are reproduced by permission of the Estate of A W Freud et al., by arrangement with Paterson Marsh Ltd., London.
Library of Congress Control Number: 2006925198
ISBN # 0-9779789-0-7

In commemoration of the 150th anniversary
of
Sigmund Freud's birth
on
May 6, 1856



See Plate 6.

The Role of Scientific Drawings in 19th- and Early 20th-Century Research

Lynn Gamwell

THIS EXHIBITION PRESENTS drawings of cells, especially nerve cells, and diagrams of the workings of the human mind that Sigmund Freud made throughout his long career, beginning in 1876 when he was a 20-year-old student, and drawing his last image in 1933, four years before his death at 83. This complete collection of Freud's diagrams includes some famous icons of psychoanalysis and other relatively unknown, rarely-seen images. As curator, I was honored that the multi-talented Mark Solms agreed to help bring these images to life for us. Fluent in German and in the medical vocabulary of Freud's era, Solms began by translating Freud's original captions. Learned in neurology, psychoanalysis and the history of psychiatry, Solms then described each image, offering thoughts about what these pictures tell us about Freud's journey from neurology to psychoanalysis. In my introduction to Solms' rich text, I will comment on the role played by such drawings and diagrams in the history of science in Freud's era.

Nineteenth-century scientists used drawing as a tool to record observations that they made looking through a microscope. As a medical student Freud learned to prepare a thin slice of animal tissue, which was usually dead, by pressing it between two pieces of

glass. Using chemical dyes Freud stained the colorless tissue to bring out details, such as nerve fibers or a cell nucleus. Looking through the microscope Freud saw light transmitted through the transparent tissue, with the stained bodies standing out in silhouette. Thus Freud's earliest diagrams of cells and nerve tissue are typically simple outlines of overall, flat shapes, within which the relations of the various parts are delineated.

Freud viewed the micro-world through a so-called "achromatic" lens that had been invented in the 1830s; because it was composed of layers of glass, each of which had different rates of refraction, the lens avoided the chromatic distortion from which earlier lenses suffered and produced an enlargement in crystal-clear focus, inspiring a flurry of investigation of microorganisms and cells. Other experimenters with lenses in the 1830s, Louis-Jacques Daguerre and William Henry Talbot, invented photography and used early cameras and projection microscopes to capture images of microorganisms, such as dust mites, as well as tissue samples of cells. However, such early, albeit grainy, mechanical recordings were treated as little more than curiosities, and drawing by hand remained the method of choice for 19th-century researchers using microscopes because their goal was not to capture the exact appearance of their subject but to direct the viewer's attention to selectively chosen details that they depicted within a general, schematic outline.

Nineteenth-century scientists also used diagrams to help them formulate a hypothesis about things they could not see. Within a decade of having drawn his first cells, Freud was diagramming mental processes for which, given the physiology of his day, he lacked the tools to observe the presumed physical substrate. Purely speculative, Freud used his diagrams to guide his research and to predict an effect that could be observed. Then, as we witness in the exhibition, as Freud focused on increasingly complex mental functions such as disorders of language and memory, he put aside any attempt to diagram the underlying physiological structure, such as neurological pathways, and he began making schematic images of hypothetical psychological structures.

In Freud's day attitudes towards the scientific value of a diagram made from life, as opposed to a diagram of a speculative structure

or hypothetical process, reflected traditional philosophical debates about where reality lies. The Enlightenment philosophers John Locke and David Hume were British Empiricists who held that one can only know with certainty what one experiences directly – seeing is believing. In the wake of the French Revolution, early 19th-century social reformers in France and Britain first expressed the outlook of positivism: science gives the only valid ("positive") knowledge. Scientists imported these attitudes into 19th-century British and French laboratories where researchers shunned theory and only trusted direct observation, perhaps aided by a microscope. Thus pictures drawn through a microscope were welcome in the halls of science in London and Paris, but theoretical diagrams of hypothesized, unseen realms were dismissed with disdain.

In Germany, however, Enlightenment philosophy had culminated at the close of the 18th century with Immanuel Kant's critiques of the foundations of human knowledge in which he declared that one only knows with certainty the contents of one's own mind, or "ideas." According to Kant's German Idealism, it is physically impossible for a scientist to observe the natural world directly because one knows flowers and songbirds only as mental constructions made out of sensory appearances (colors, sounds). As science developed in Germanic culture, many researchers adopted this outlook and treated sensations of colors and shapes as signs of an ultimately unknowable world-out-there (Kant's so-called "thing-in-itself"). Thus German researchers were comfortable using theoretical models such as diagrams of unseen realms to guide their investigations. But as the scientific method gradually replaced philosophical debate, in order to be confirmed a theory had to predict results that were observable by all. Thus in German laboratories drawings depicting what was seen through a microscope became one method of providing the indispensable observation that supported and helped to confirm a theoretical model.

It was researchers working within this German-speaking scientific community who led the investigation of the inherently unobservable human psyche. The leading German scientist of the second half of the 19th century, Hermann von Helmholtz, grounded Kant's idealist view of human knowledge in the body by demonstrating,

in repeatable experiments, how the eye and the ear respond to light and sound, and how humans construct a world picture from abstract signs (nerve impulses): "The nature of the sensation depends primarily on the peculiar characteristics of the (receptor) nervous mechanism; the characteristics of the perceived object being only a secondary consideration. . . . The quality of the sensation is thus in no way identical with the quality of the object by which it is aroused. Physically, it is merely an effect of the external quality on a particular nervous apparatus. The quality of the sensation is, so to speak, merely a symbol for our imagination."[1] Trained in the Helmholtz school of physiology and neurology, of which his teacher Ernst Brücke was a prominent member, Freud compared knowledge of the internal (psychological) world with knowledge of the external (physical) world as described by Helmholtz: "The unconscious is the true psychic reality; in its innermost nature it is as much unknown to us as the reality of the external world, and it is as incompletely presented by the data of consciousness as is the external world by the communications of our sense organs" (*The Interpretation of Dreams*, 1900).[2]

Helmholtz urged all scientists to find a balance between theoretical speculation and observed data, as he put it, between "a penetrating knowledge of theory" and a "broad, practical experience in experiment." He criticized French scientists for being too narrowly focused on collecting facts, but he felt that certain German scientists, such as his contemporary, the evolutionary biologist Ernst Haeckel, erred in the opposite direction by not sufficiently grounding their hypotheses in laboratory data: "To flee into an ideal world is a false resource of transient success . . . when knowledge only reflects itself, it becomes insubstantial and empty, or resolves into illusions and phrases."[3] Freud shared Helmholtz's view that a theory that was unsupported by observation in controlled laboratory experiments was not science but "phrases" – in other words, a philosophical theory that was confirmed or refuted, not by experiment, but by endless argument, heralding a return to a pre-scientific era. Freud labored throughout his career to make psychoanalysis as rigorous a science as the elusive psychic data he observed in his laboratory – his consulting room – would allow.

Meanwhile direct observation remained the rule in France, where in 1865 the chemist Louis Pasteur had revolutionized medicine by announcing the germ theory of infectious disease, based upon his observations of microbes. In England Charles Darwin had amassed a mountain of detailed observations in support of his theory of evolution by natural selection, but he enraged his critics by picturing the process of natural selection in a theoretical diagram – a tree of life – on the frontispiece to *The Origin of Species* (1859). Widely denounced in the halls of British science because the process of natural selection was unobservable, Darwin's theory was also rebuffed in Parisian laboratories, where Pasteur remarked: "There are many great problems that arouse interest today: the unity or multiplicity of human races; the creation of man many thousands of years or centuries ago; the immutability of species or the slow and progressive transformism of one species to another; matter reputed to be eternal rather than created; the idea of God being useless, etc.; these are some of the learned questions that men dispute today. . . . I do not discuss these grave topics. . . . I dare speak only on a subject that is accessible to direct observation."[4]

When Freud went to Paris in 1885-86 to study with the leading neurologist of the day, Jean-Martin Charcot, he entered the Salpêtrière Hospital at a rare moment in French psychiatry when unseen, psychological causes of mental derangement were being studied. After a distinguished career in which he considered only physical causes of mental illness, in 1882 Charcot had presented his first paper in which he declared that there are purely psychological causes of hysteria that could be investigated using hypnosis. After Charcot's death in 1893 Parisian neurologists were determined to return to studying only observable behavior and physical features of the mind. They closed the Salpêtrière laboratory for experimental psychology that Charcot had entrusted to his student, Pierre Janet, and French psychiatrists returned to considering only physical (chemical and neurological) disorders well into the early 20th century.

In Germanic lands scientists were not only sympathetic to a theoretical approach but also drawn to the vibrant spirit of Darwin's core idea: nature is a web of dynamic forces without predetermined

purpose or meaning. In the 1860s Darwin's natural selection became generally accepted by German-speaking scientists as a master narrative that explained the natural sciences, and some, such as the Russian embryologist, Alexander O. Kovalevsky, made significant contributions to evolutionary biology. By the fin-de-siècle Freud was crafting an evolutionary model of the mind, diagramming trees of branching neurons, and he went on to describe man as an animal driven by passions to reproduce and aggressions to survive.

Another British scientist, Isaac Newton, had written the greatest theoretical pronouncement of early modern science, the law of universal gravitation that described the (unobserved) force that holds the universe together. Like Darwin's pictorial diagram of the tree of life, Newton summarized his law in another abstract language, mathematics. Newton emphasized the theoretical nature of his accomplishment by titling his 1687 treatise *Philosophiae Naturalis Principia Mathematica* (Mathematical Principles of Natural Philosophy) and he stated at the outset: "I have design to give only a mathematical notion of the forces, without considering their physical causes." In other words he gave a mathematical description of an invisible force whose physical nature was unknown to him. In an intellectual climate dominated by British Empiricism, Newton despaired in private that he found the whole idea of gravity – an unobservable force that acts at a distance – ridiculous.[5] But after a century of accurate predictions, even Empiricists got accustomed to the idea that apples fall down, not up, because of gravity. Then at the opening of the 19th century, during a flurry of experiments on electricity and magnetism as well as early studies of the electrical properties of nerve fibers, certain German scientists who admired Newton's law as the pinnacle of theoretical physics, set their goal on becoming the Newton-of-the-mind. Newton had discovered the force driving the cosmos and they wanted to discover the force driving the mind. That honor fell to the German physicist Gustav Theodor Fechner, who, during a dramatic recovery from depression and blindness, discovered that the force driving his own mind was the intense pleasure he felt when he re-entered the world of life and light. He generalized this finding to all humans, and attempted to bridge the gap between theory and observation by proving a "psychophysical law"

relating an observable (objective) physical cause to an experienced (subjective) psychological effect (*Psychophysics,* 1860). In the early 20th century Freud acknowledged Fechner's pleasure principle as a fundamental force in the mind: "An investigator of such penetration as G. T. Fechner held a view on the subject of pleasure and unpleasure which coincides in all essentials with the one that has been forced upon us by psychoanalytic work" (*Beyond the Pleasure Principle,* 1920).[6]

Freud moved back and forth between pictures based on observation and on theory in his pursuit of the elusive human psyche. Along the way he visualized his ideas about the psyche by an intellectual process that resonates with dreamwork, during which the sleeping mind begins with abstract concepts and ends with a picture: "On this path, which is the reverse direction to that taken by the course of development of mental complications, the dream-thoughts are given a pictorial character; and eventually a plastic situation is arrived at which is the core of the manifest 'dream-picture'."[7] Traces of Freud's journey from neurology to psychoanalysis can be found in Freud's diagrams that Mark Solms describes in fascinating detail.

1. Hermann von Helmholtz, "The Theory of the Sensation of Vision," *Handbook of Physiological Optics,* (1856-67; reprint, New York: Dover, 1962), vol. 2, p. 4.

2. *The Standard Edition of the Complete Psychological Works of Sigmund Freud,* trans. James Strachey (London: Hogarth Press, 1953-74), vol. 5, p. 613.

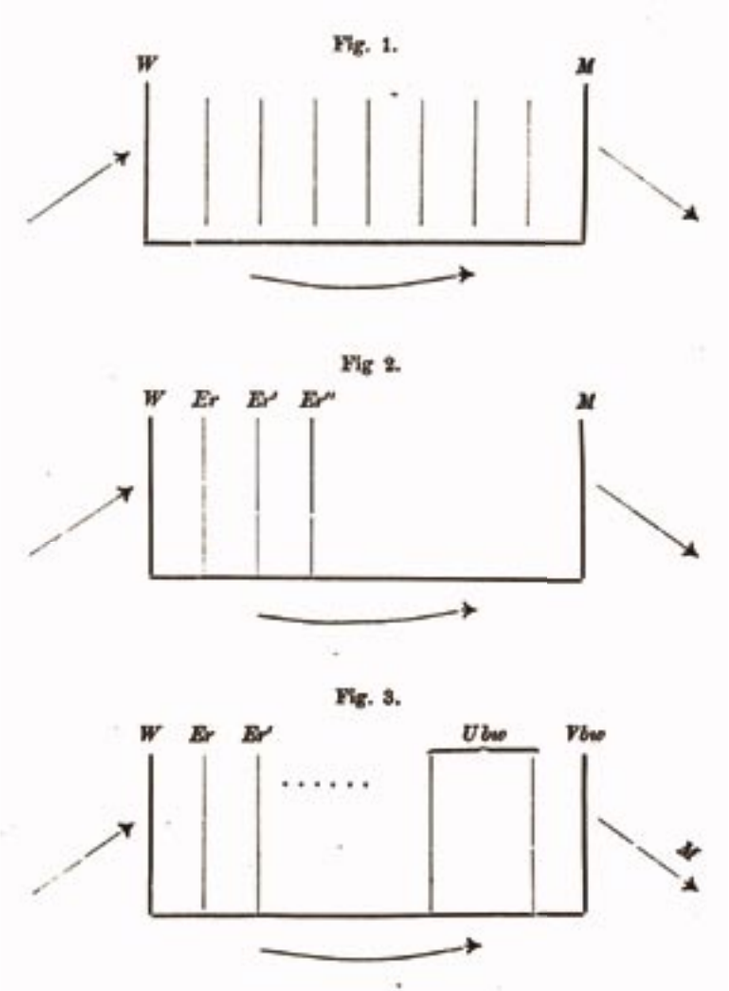
3. Hermann von Helmholtz made the remark in "Gustav Magnus. In Memoriam," *Popular Lectures on Scientific Subjects,* trans. E. Atkinson (London: Longmans, Green, 1881), vol. 2, pp. 1-25.

4. Louis Pasteur, "Chimie appliquée à la physiologie: des générations spontanées," *Revue des Cours Scientifiques* 1, no. 21 (April 23, 1864), p. 257.

5. As Newton lamented in a letter to the classical scholar Richard Bentley: "That one body may act upon another at a distance through a vacuum without the mediation of anything else, by and through which their action and force may be conveyed from one to another, is to me so great an absurdity that, I believe, no man who has in philosophic matters a competent faculty of thinking could ever fall for it."

6. *Standard Edition,* vol. 18, p. 8.

7. *Jokes and Their Relation to the Unconscious* (1905), *Standard Edition,* vol. 8, p. 162.



See plate 40.

Sigmund Freud's Drawings

Mark Solms

THIS COLLECTION OF FREUD'S complete scientific drawings, assembled by Lynn Gamwell to commemorate the 150th anniversary of Freud's birth, gives us an unprecedented opportunity to reflect on the nature of his contribution to science – and even on the nature of science itself.

There is an obvious progression in the drawings. The first group, dating from 1876, depicts in meticulous detail the morphology of specific anatomical structures, such as the gonads of the eel, the spinal neurons of the lamprey and the fiber pathways of the human brain. The last drawings, dating to 1933, by contrast, are diagrammatic depictions of abstractions such as the "ego", "superego" and "id" – conceptual entities that have no tangible existence in the physical world.

This progression coincided with the well-known shift in Freud's scientific career, away from his early researches in histology and anatomy, via neuropathology and clinical neurology, to his later work in neuropsychology and psychoanalysis. Anatomy is, of course, concerned with concrete, physical things; psychoanalysis with the fleeting and fugitive stuff we call "mind."

It therefore comes as no surprise to learn that Freud's shift from

neuroscience to psychoanalysis coincided with a change in his status as a scientist. Freud himself drew attention to this change, more or less at the moment the shift was made, when he wrote in his *Studies in Hysteria* that:

"It strikes me myself as strange that the case histories I write [here] … lack the serious stamp of science. I must console myself with the reflection that the nature of the subject is evidently responsible for this, rather than any preference of my own."[1]

Freud clearly did not welcome the change. Looking back over his career 30 years later in his Autobiographical Study, his longing for the comfortable respectability of his earlier career is still evident:

"At length, in Brücke's physiological laboratory, I found rest and full satisfaction – and men, too, whom I could respect and take as my models: the great Brücke himself, and his assistants."[2]

What, then, prompted Freud to make this transition? It most certainly was not the abandonment of science. Freud never tired of reminding his readers that as far as he was concerned, psychoanalysis was a natural science like any other – at least insofar as its aims and methods were concerned. In this, despite appearances to the contrary, he followed the scientific ideals of "the great Brücke" who had pledged a solemn oath to the effect that:

"No other forces than the common physical and chemical ones are active within the organism. In those cases which cannot at the time be explained by these forces, one has either to find the specific way or form of their action by means of the physical-mathematical method or to assume new forces equal in dignity to the chemical-physical forces inherent in matter, reducible to the forces of attraction and repulsion."[3]

Freud always remained true to these ideals. All that changed, as he plainly stated in the first quotation, was "the nature of the subject." Since the chemical-physical forces inherent in matter obviously cannot readily be used to explain the mental aspects of the organism, Freud had to "assume new forces equal in dignity to the chemical-physical ones" when he turned his attention to the mind. This was what his transition from anatomy to psychoanalysis boiled down to. Accordingly, as we shall see, there was more that united the two phases of Freud's scientific work than divided them.

What united them was the reductive aim outlined in Brücke's "solemn oath," that is, the goal of reaching beyond the appearance of phenomena to discover their essential nature. To understand the essence of things demands that one finds a way to see more deeply into them; to discern things that are not apparent to the naked eye. Many things in nature exist that cannot be seen. It is the fundamental task of science to discover such things, which bring order to the observable world, for they explain it. All of Freud's work was an attempt to do this – with respect to one particular part of the world, namely the human brain (or nervous system). This is clearly reflected in his drawings.

His first, histological studies of the eel, lamprey and crayfish (grouped under plates 1-21) are straightforward attempts to discern morphological details which are too small for the eye to see. For the purpose of these studies, Freud used a simple instrument: the microscope designed by Hartnack. This enabled him to make individual cells appear up to 520 times bigger than they actually are.

In the next phase of Freud's research, anatomical studies of the human brainstem (plates 22-29), he again made use of the microscope, but the greater complexity of the task required additional observational aids. He wanted to trace the paths followed by particular nerve tracts and identify the nuclei in which they terminate, within an impossibly dense thicket of tracts and nuclei called the medulla oblongata. He therefore adopted a new method pioneered by a colleague named Paul Flechsig: he traced the tracts in relatively undeveloped fetal brains, where the task was accordingly simpler, and then retraced them with greater ease in mature specimens.

Tracing the myriad tracts that interconnect the grey matter of the brain serves only one purpose: to infer what the different parts of the brain *do*. This is called *functional* neuroanatomy. The elucidation of brain function is the ultimate task of all neurological science; and it was, likewise, the culmination of Freud's anatomical work.

Of critical importance in this regard is the bald fact that functions cannot be seen; they have to be deduced. This does not make functions any less *real* than structures. They lack direct observability because they are *dynamic* things; they only exist over time – they involve processes. And such things cannot be easily drawn.

To make matters worse, Freud was not interested in *simple* physiological functions. His interest quickly turned to one of the most complex functions of the human brain: the function of language – a "psychological" function. Freud's studies in this area (see plates 30-31) are accordingly described as neuropsychological studies. However, the interaction between the neurons subserving language is no more or less visible (or real) than those for any other function; it is simply a matter of degrees of complexity.

The transition from representational pictures to abstract diagrams necessitated by these facts can be followed, step by step, in Freud's drawings. They make it absolutely clear that the shift from neurology to psychology was not an ontological one; he was always concerned with the same basic subject – namely, how the brain worked. In fact, the shift of emphasis from structure to function occurred long before he developed psychoanalysis, while he was still a full-fledged neuroscientist.

The further transition from *neuro*psychology to *meta*psychology occurred via an intermediate step, represented by the drawings in plates 32-39 below. These are a series of rough diagrams that Freud prepared for his friend Wilhelm Fliess (including those for the famous manuscript known as the "Project for a Scientific Psychology"). Here, as he did in his work on the neuropsychology of language, Freud attempted to infer the neural arrangements that produce other complex mental functions. However, for these functions, anatomical and physiological knowledge was entirely lacking. This was because the clinical phenomena from which Freud inferred things like repression – unlike the language disorders that Freud had studied previously – were not caused by structural lesions of the brain. The only way that he could infer such mechanisms, therefore, was directly from clinical observation. There was no pathological anatomy and therefore no empirical basis for discovering the neural vehicles of such functions. This led Freud, reluctantly, to abandon conventional neuroscientific ground.

This was the breakthrough into psychoanalysis proper. But a comparison between Freud's last neuropsychological drawing (plate 39) and his first metapsychological one (plate 40) reveals unequivocally that little had really changed. The drawings were almost identical;

the systems of "neurons" were merely re-named "mental" systems. The drawings still depicted the same thing, namely, the succession of changes that occur during processing of stimuli, as they proceed from the perceptual to the motor end of the apparatus.

The method by which Freud inferred these processes was now the psychoanalytic method. But for him this new method was not fundamentally different from the microscope, as regards its scientific aims. The rationale behind both methods was to extend as far as possible the observational capacities of our senses (for outer and inner perception respectively) in order to provide the deepest basis for making inferences about underlying functions – which, in themselves, can never be observed directly.

Freud was only too aware that, proceeding in this way, he would never be absolutely sure that his conclusions were correct. This, too, applies to all science. Certainly, the more complex the phenomena under study, the less secure the inferences as to underlying mechanisms. But this is no basis for limiting science to the study of simple things. Science must study nature as it is and remain appropriately modest about its powers – especially in our own time, when we seem to believe that we can control everything, know everything and have everything; when we are told by social scientists that we have reached "the end of history"[4]and by natural scientists that we will shortly "know the mind of God."[5] It is fitting to celebrate the life of a scientist who, although no less curious about the ultimate nature of things, was still willing to admit that "reality in itself will always remain unknowable."[6]

Between the transient superficies of the senses on the one hand and the false certainties of religion on the other, lies the uncertain path of the truth-seeking scientist. These unique drawings are signposts along the path taken by one such person.

1. Sigmund Freud, "Case 5: Fräulein Elisabeth von R." (1895) in Studies in Hysteria (1893-95), *The Standard Edition of the Complete Psychological Works of Sigmund Freud,* trans. James Strachey (London: Hogarth Press, 1953-74), vol. 2. p. 160.

2. Sigmund Freud, "An Autobiographical Study" (1925), *Standard Edition,* vol. 25, p. 9.

3. E. Du Bois-Reymond (1842) Zwei grosse Naturforscher des 19. Jahrhunderts: Ein Briefwechsel zwischen Emil Du Bois-Reymond und Karl Ludwig. (Leipzig: Barth, 1927).

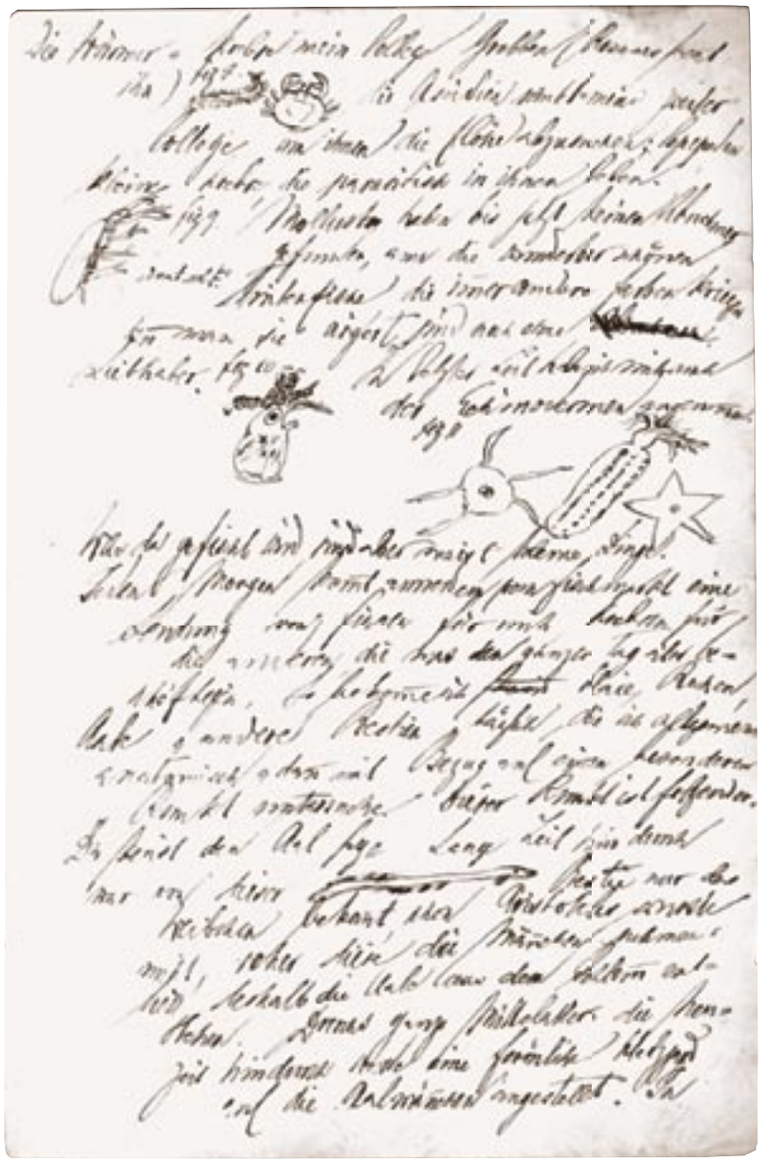
4. Francis Fukuyama, *The End of History and the Last Man* (New York: Free Press, 1992).

5. Stephen W. Hawking, *A Brief History of Time* (London: Bantam Books, 1988).

6. Sigmund Freud, *The Interpretation of Dreams* (1900), *Standard Edition,* vol. 5, p. 613.

ILLUSTRATIONS

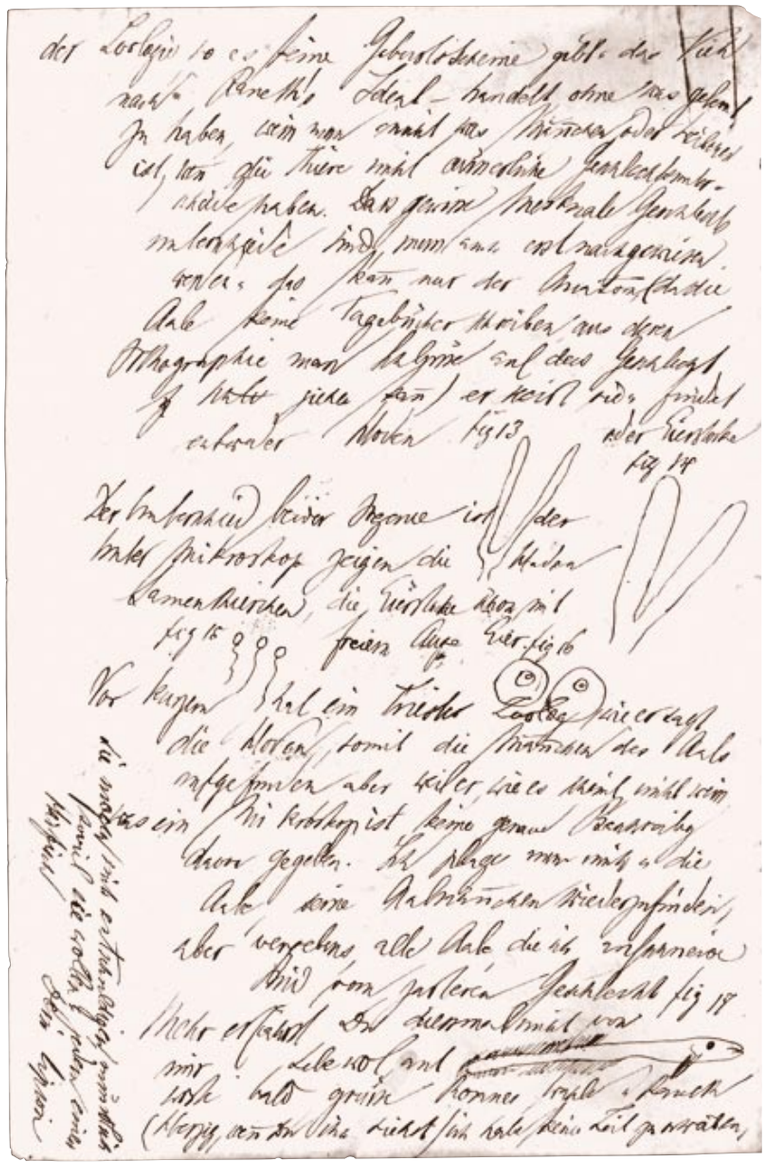
The translation of Freud's legends for the drawings and the comments on the drawings are by Mark Solms.



1a.

1. Zoological drawings in a letter Freud wrote from Trieste to Eduard Silberstein, April 5, 1876, Figs. 7-12. Sigmund Freud Collection, Library of Congress.

1b.



2.

2. Zoological drawings in a letter Freud wrote from Trieste to Eduard Silberstein, April 5, 1876, Figs. 13-17. Sigmund Freud Collection, Library of Congress.

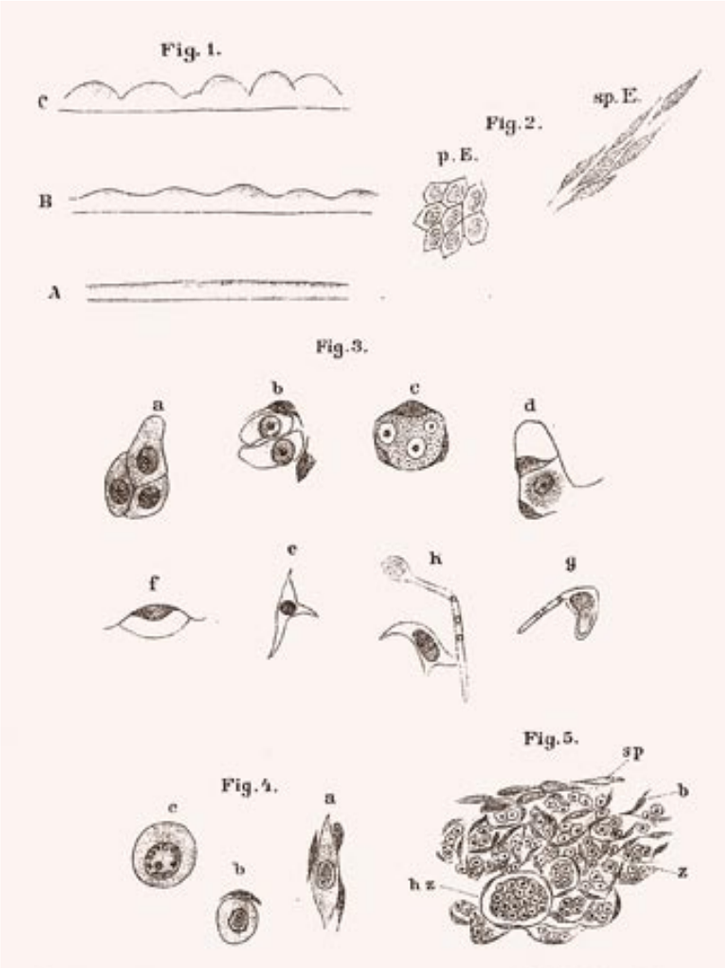
EXTRACT FROM FREUD'S LETTER:

"I obtain sharks, rays, eels and other creatures daily [Figs. 7-11], which I investigate first from the general anatomical viewpoint and thereafter with regard to one particular problem. This problem is the following. You know the eel. [Fig. 12] Of this creature, since time immemorial, only the female has been recognized; even Aristotle did not know where the male of the species was, and thus how the eel was able to rise from the primal mud. Through the whole of the middle ages and throughout modern times a formal hunt has been on for the male eel. In Zoology, where there are no birth certificates and the beasts behave in accordance with Paneth's ideal – without training – one does not know which is male and which is female when the animal does not possess external sexual differences. That certain distinguishing features are indeed sexual differences must also first be demonstrated, and that is up to the anatomist (since eels do not keep diaries from the orthography of which one may deduce gender); he therefore dissects them and discovers either testicles [Fig. 13] or ovaries [Fig. 14]. The difference between the two organs is this: under the microscope the testicles contain spermatozoa [Fig. 15] and the ovaries – even to the naked eye – contain eggs [Fig. 16]. Not long ago a Trieste zoologist discovered, he says, the testicles, and thereby the male eel; but since it seems he does not know what a microscope is, he did not provide a detailed description of them. Now I am toiling to re-discover this eel, his male eel; but in vain, all the eels which I cut open are of the fairer sex [Fig. 17]. On this occasion you shall learn nothing more from me."

Comment:

The initial phase of Freud's scientific activity was devoted to histology. His first piece of research was a study of the sexual anatomy

of the eel. Freud's search for the testicle of the eel was conducted at the University of Vienna's biological station in Trieste. In this extract from a letter to a childhood friend, he caricatures his scientific efforts.



3. “Über das Syrskische Organ” (On the Origin of Syrski’s Organ), *Sitzungsberichte der Mathematisch-Naturwissenschaftlichen Classe der Kaiserlichen Akademie der Wissenschaften,* LXXV. Band. I. Abtheilung (1877).

Fig. 1. The main forms of the lobular organ. Schematic drawing.
A = organ without lobules.
B = organ with thin hyaline lobules.
C = mature lobular organs.

Fig. 2. Isolated epithelia of the lobular organ fixed in Muller’s fluid.
p.E. = polygonal epithelia.
sp.E = spindle-cell epithelium.

Fig. 3. Content-cells and connective tissue elements of the isolated lobular organ fixed in Muller’s fluid.
Magnified after Hartn[ack] 4/8.
a = three content cells.
b = two cells surrounded by connective tissue elements.
c = nuclei in finely granulated protoplasm enclosed by connective tissue bodies.
d = two connective tissue elements linked together with bracket-shaped processes framing a cell.
e = connective tissue cell within a large area of protoplasm.
f = connective-tissue cell with ring-shaped bracket.
g = connective tissue element with bracket-like process.
h = unusual form of connective tissue elements with an angular bracket.

Fig. 4. Unusual cells from a small lobule. a and b fixed in Muller’s fluid, c fixed in superosmic acid; the cells are surrounded by spindle-shaped bodies.

Fig. 5. View of a small piece from the margin of the lobular organ between two lobules.
sp. spindle cell.

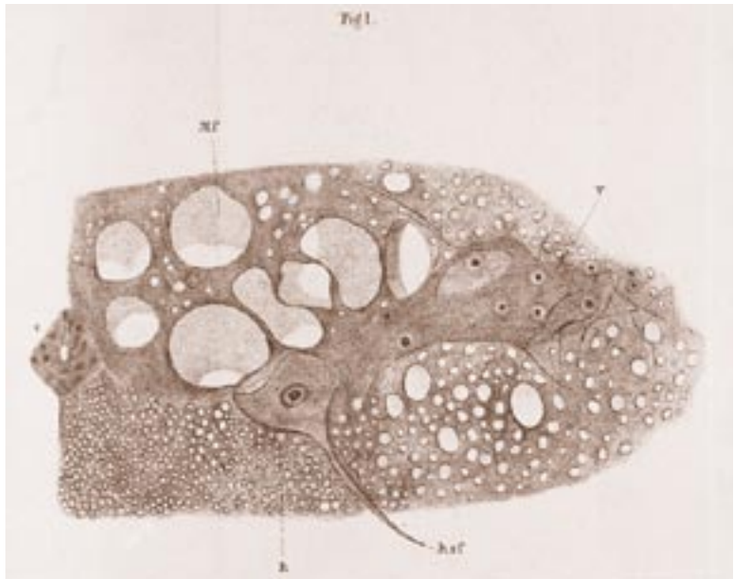
b. connective tissue element.
z. cells of the lobular organ.
hz. cells of the lobular organ arranged in small clusters.

Comment:

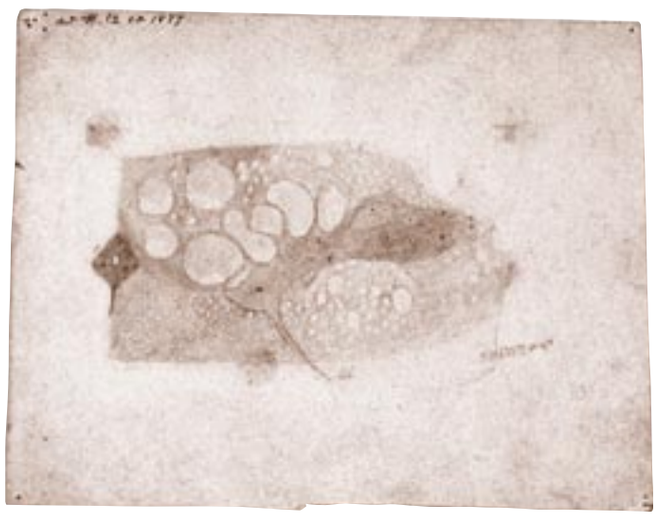
The testicles of the eel had been a puzzling anatomical problem for centuries, for no one could find them – and this made it difficult to imagine how the species reproduced. In this study Freud dissected, in 400 specimens, a lobular organ which a colleague had identified as a likely candidate. In the end, to his disappointment, he could not definitely decide whether this organ was the elusive testicle or not. We now know why: the primitive form of the animal that he dissected was *intersexual* (having both male and female characteristics). Is it not remarkable that the future discoverer of the castration complex began his scientific career by searching, without success, for the missing testicles of the eel?

The lobular organ is seen in Fig 1. Figs. 2-5 depict the cellular structure of its outer layer and its inner contents.

"Über den Ursprung der hinteren Nervenwurzeln im Rückenmark der Petromyzon von Ammocoetes (Petromyzon Planeri)" (On the Origin of the Posterior Nerve Roots in the Spinal Cord of Ammocoetes (Petromyzon Planeri)), *Sitzungsberichte der Mathematisch-Naturwissenschaftlichen Classe der Kaiserlichen Akademie der Wissenschaften,* LXXV. Band. I. Abtheilung (1877).



4.



Freud's original drawing (bottom) for the published illustration (top). Ink on paper. Freud Museum, London.

4. "Über den Ursprung der hinteren Nervenwurzeln im Rückenmark der Petromyzon von Ammocoetes (Petromyzon Planeri)" (On the origin of the Posterior Nerve Roots in the Spinal Cord of Ammocoetes (Petromyzon Planeri)), *Sitzungsberichte der Mathematisch-Naturwissenschaftlichen Classe der Kaiserlichen Akademie der Wissenschaften,* LXXV. Band. I. Abtheilung (1877). The New York Academy of Medicine.

Fig. 1. Half of a transverse section of the spinal cord of the Ammocoetes, fixed in Muller's fluid. A segment is missing from the anterior, external corner [top right].

c. = central canal.
h. = posterior cell.
hzf. = posterior-cell process.
M.f. = Muller's fibre.
v. = anterior horn.

5.

Freud's original drawing (bottom) for the published illustration (top). Ink on paper. Freud Museum, London.

5. "Über den Ursprung der hinteren Nervenwurzeln im Rückenmark der Petromyzon von Ammocoetes (Petromyzon Planeri)" (On the Origin of the Posterior Nerve Roots in the Spinal Cord of Ammocoetes (Petromyzon Planeri)), *Sitzungsberichte der Mathematisch-Naturwissenschaftlichen Classe der Kaiserlichen Akademie der Wissenschaften,* LXXV. Band. I. Abtheilung (1877). The New York Academy of Medicine.

Fig. 2. A transverse section through the whole of Ammocoetes; chromic acid preparation. The tissues surrounding the central canal are incompletely drawn.

ch. = chorda dorsalis.
chs. = the three layers of the internal chordal sheath.
d. = dura mater.
p. = pia mater.
ar. = cells and elastic fibres in the arachnoid space.
m. = muscle segments
n.l. = transverse section of the nervus lateralis
M.f. = Muller's fibre.
c. = central canal.
h. = posterior cell.
h.f. = posterior-cell fibre.

Adjacent are other root fibres.

f. = which cannot be followed as far as the posterior cells.
h.w. = posterior root.
s.g. = surrounding fatty tissue within which the cartilaginous skeleton of the Petrmomyzon is embedded.

Comment:

The study for which these drawings were prepared was Freud's first neuroscientific publication. This study (which continued into the following two) was concerned with the histology of the nerve cell – the basic element of nervous tissue. The drawings show sections through the spinal cord of a primitive fish called Petromyzon or Ammocoetes, commonly known as the lamprey. Freud's scientific task was to describe the structure of particular nerve cells and fibers

in the spinal cord of this species, and discuss them in relation to others. The nerve cells are indicated in both drawings by the letter h. The fibers attached to the cell bodies (axons) are indicated by the letters hf and hzf.

The following quotation, made in 1953 by Freud's biographer Ernest Jones, describes the broader context:

> "Together with the problem of the intimate structure of nervous elements … [there was the] question of whether the nervous system of the higher animals is composed of elements different from those of the lower animals, or whether both are built of the same units. This topic was highly controversial at that time. The philosophical and religious implications seemed to be very disturbing. Are the differences in the mind of lower and higher animals only a matter of degree in complication? Does the human mind differ from that of some mollusc – not basically, but correlative to the number of nerve cells in both and the complication of their respective fibres? Scientists were searching for the answers to such questions in the hope of gaining definite decisions – in one way or another – on the nature of man, the existence of God, and the aim of life." (*Sigmund Freud: Life and Work* [London: Hogarth Press, 1953, p. 51]).

To this vast and exciting field of research, these early studies of Freud's belong.

"Über Spinalganglien und Rückenmark der Petromyzon" (On the Spinal Ganglia and Spinal Cord of Petromyzon), *Sitzungsberichte der Mathematisch-Naturwissenschaftlichen Classe der Kaiserlichen Akademie der Wissenschaften,* LXXVIII. Band. I. Abtheilung (1878).

Plates I–IV

6.

Freud's original drawing (bottom) for the published illustration (top). Ink on paper. Freud Museum, London.

6. "Über Spinalganglien und Rückenmark der Petromyzon" (On the Spinal Ganglia and Spinal Cord of Petromyzon), *Sitzungsberichte der Mathematisch-Naturwissenschaftlichen Classe der Kaiserlichen Akademie der Wissenschaften,* LXXVIII. Band. I. Abtheilung (1878). The New York Academy of Medicine.

Plate I

Fig. 1. Spinal ganglion of Petromyzon, gold stain, drawn with Hartnack Ocular 3, objective 8 and X, magnification 520.

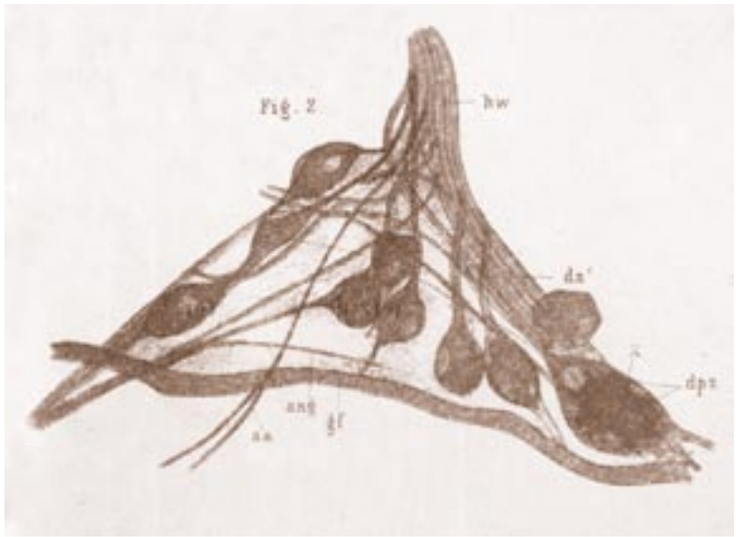
Spinal ganglion with 15 cells, five larger and one small cell in ventral branch, eight medium-sized and one small cell in dorsal branch. The differences in size between dorsal and ventral cells are not great. Both processes of all 13 cells of the first and second magnitude can be traced. In the dorsal branch is a Ranvier cell *RZ*. The last dorsal cells somewhat displaced.

The central process of cell *n* torn off. The only visible nucleus is on cell *c*. The other nuclei cannot be recognized due to excessive staining of cells.

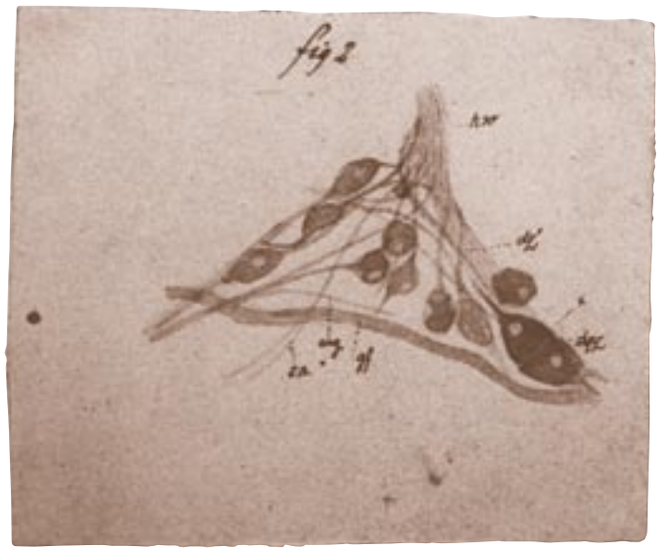
Two broad, through-going fibres *dz* in the ventral branch. Many medium-sized through-going fibres in both branches.

Anaclitic fibres clear at *ang*. Two sympathetic fibres are present.

HW = posterior root.
vA = ventral branch.
kz = small cell.
dA = dorsal branch.
gz = large cell.
zf = cell fibres.
ang = anaclitic fibres.
sA = sympathetic branch.
dz = broad through-going fibre.
dz = medium-sized through-going fibre.
wf = fibre twisting round root.
RZ = Ranvier cell.



7.



Freud's original drawing (bottom) for the published illustration (top). Ink on paper. Freud Museum, London.

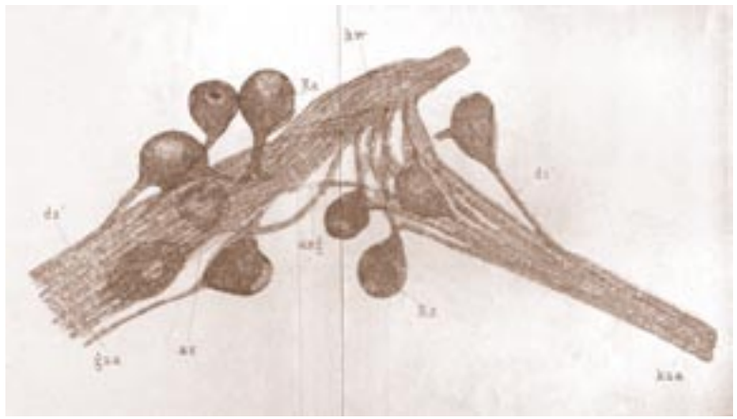
7. "Über Spinalganglien und Rückenmark der Petromyzon" (On the Spinal Ganglia and Spinal Cord of Petromyzon), *Sitzungsberichte der Mathematisch-Naturwissenschaftlichen Classe der Kaiserlichen Akademie der Wissenschaften,* LXXVIII. Band. I. Abtheilung (1878). The New York Academy of Medicine.

Plate I

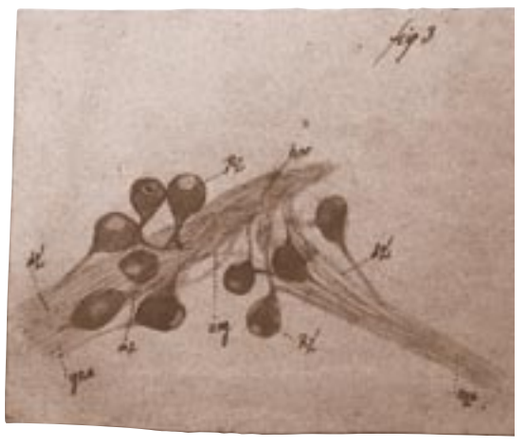
Fig. 2. Spinal ganglion of Ammocoetes, gold stain, drawn with Hartnack 2/8, obj. X could not be used. Several cells appear, therefore, unipolar. On squashing the spinal ganglion it could be seen that all cells, with the exception of the double cell *dpz*, were bipolar.

After isolation, the double cell displayed at *x* a second central process. Magnification 305.

gf = vessel.
sa = sympathetic branch.
dz = mass of through-going fibres.
hw = posterior root.
ang = anaclitic fibres.



8.



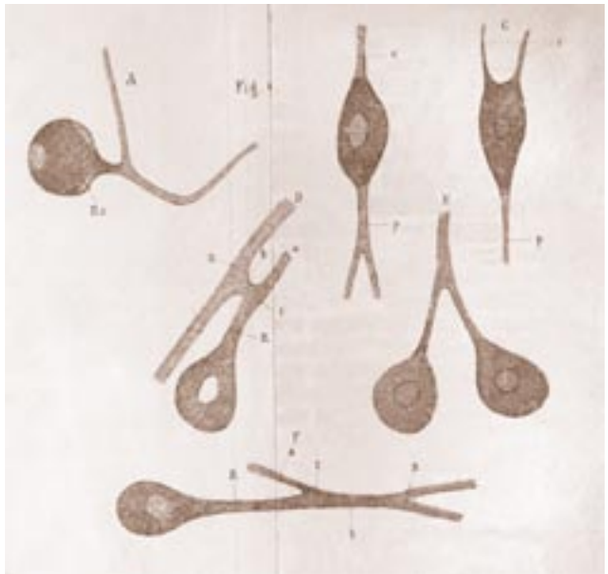
Freud's original drawing (bottom) for the published illustration (top). Ink on paper. Freud Museum, London.

8. "Über Spinalganglien und Rückenmark der Petromyzon" (On the Spinal Ganglia and Spinal Cord of Petromyzon), *Sitzungsberichte der Mathematisch-Naturwissenschaftlichen Classe der Kaiserlichen Akademie der Wissenschaften,* LXXVIII. Band. I. Abtheilung (1878). The New York Academy of Medicine.

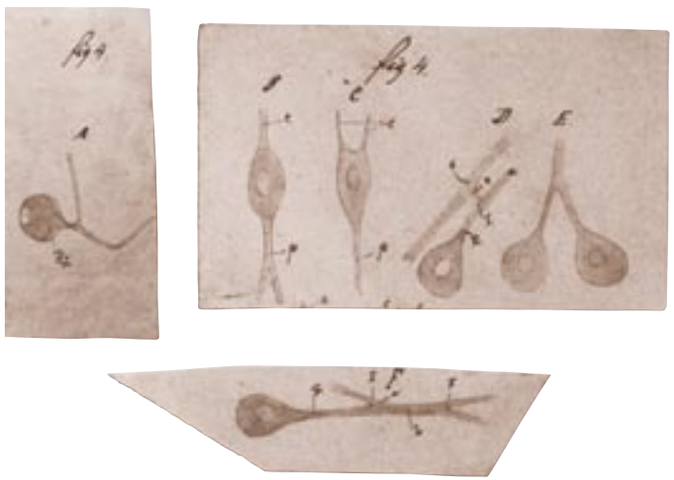
Plate I

Fig. 3. Spinal ganglion, gold stain, drawn with Hartnack 2/8, obj. X could not be used. On squashing the slide, one could see the two processes of the cell *az* which previously appeared apolar. Two Ranvier cells *Rz* and *Rz'*. The latter with very short process. Magnification 435

HW = posterior root.
gza = branch of large cell.
dz = through-going fibres.
kza = branch of small cell.
Rz, *Rz'* = Ranvier cells.
az = cell apparently without process.
ang = anaclitic fibres which describe an arc from the ventral to the dorsal branch.



9.



Freud's original drawings (bottom) for the published illustration (top). Ink on paper. Freud Museum, London.

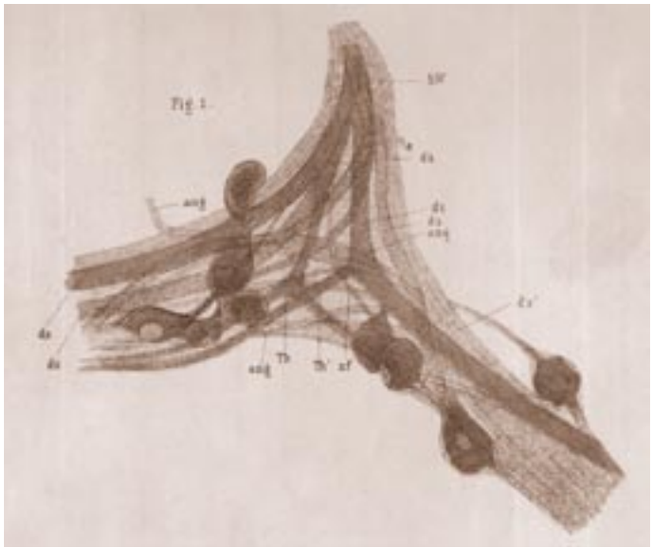
9. "Über Spinalganglien und Rückenmark der Petromyzon" (On the Spinal Ganglia and Spinal Cord of Petromyzon), *Sitzungsberichte der Mathematisch-Naturwissenschaftlichen Classe der Kaiserlichen Akademie der Wissenschaften,* LXXVIII. Band. I. Abtheilung (1878). The New York Academy of Medicine.

Plate I

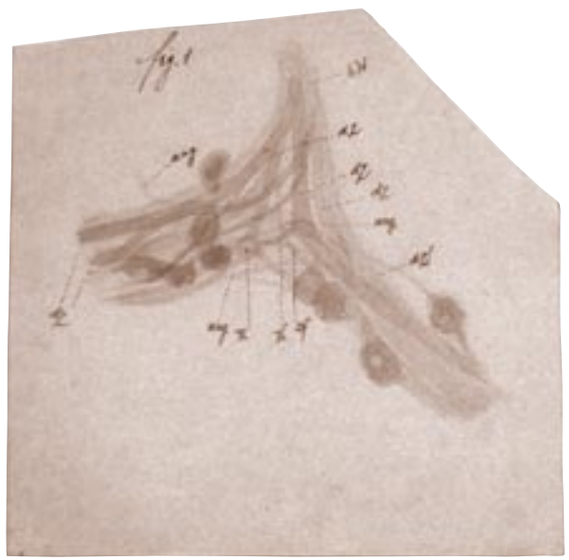
Fig. 4. *A.* Ranvier cell from one of the last spinal ganglia, gold stained.

Fig. 4 *B-F.* Isolated cells from spinal ganglia drawn from pencil sketches of the slides.

B = bipolar cell with division of the peripheral process.
C = Similar forms found in the spinal cord.
D = Ranvier cell; the process of cell *R* divides at *I.* Of the two branches, branch *b* divides again in the shape of a T at *II.*
E = Two apparently unipolar cells, the processes of which unite.
F = Ranvier cell; the process of cell *R* divides for the first time at *I,* one of the two branches (*b*) divides again, fork-shaped, at *II.*



10.



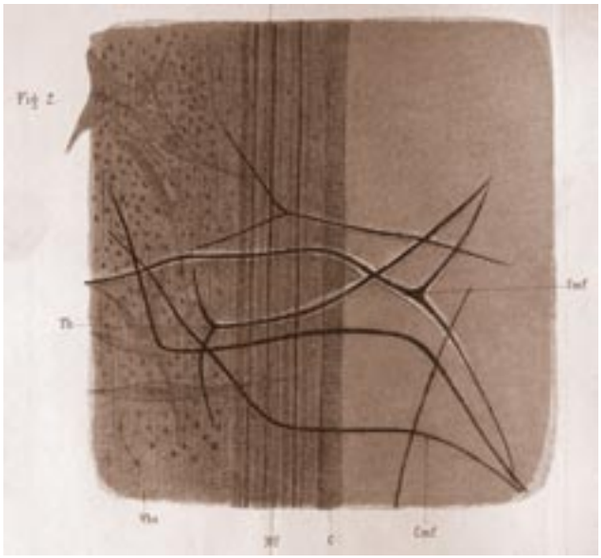
Freud's original drawing (bottom) for the published illustration (top). Ink on paper. Freud Museum, London.

10. "Über Spinalganglien und Rückenmark der Petromyzon" (On the Spinal Ganglia and Spinal Cord of Petromyzon), *Sitzungsberichte der Mathematisch-Naturwissenschaftlichen Classe der Kaiserlichen Akademie der Wissenschaften,* LXXVIII. Band. I. Abtheilung (1878). The New York Academy of Medicine.

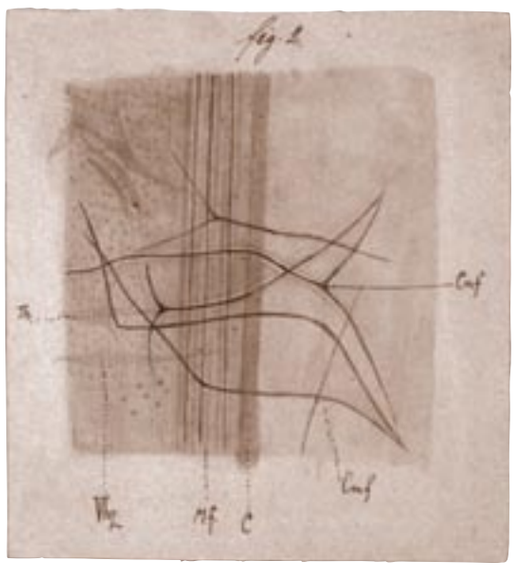
Plate II

Fig. 1. Spinal ganglion, gold stained. Drawn with Hartnack 3/8. Magnification 435. Several broad through-going fibres, some of which divide.

HW = posterior root.
dz = broad through-going fibre.
dz = through-going fibre.
zf = cell fibre.
Th = division of fibres.
Th = division of broad fibre into two branches of different width.
ang = anaclitic fibre.



11.



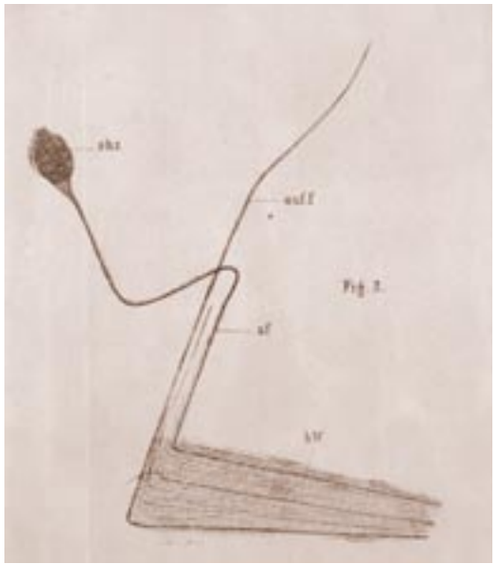
Freud's original drawing (bottom) for the published illustration (top). Ink on paper. Freud Museum, London.

11. "Über Spinalganglien und Rückenmark der Petromyzon" (On the Spinal Ganglia and Spinal Cord of Petromyzon), *Sitzungsberichte der Mathematisch-Naturwissenschaftlichen Classe der Kaiserlichen Akademie der Wissenschaften,* LXXVIII. Band. I. Abtheilung (1878). The New York Academy of Medicine.

Plate II

Fig. 2. Spinal cord of Petromyzon marinus. Viewed from anterior surface. Alcohol and carmine preparation. Magnification 115. Anterior superficial decussation of fibres.

C = central canal.
Mf = Müller's (calossal) fibre.
Vhz = anterior horn cells.
Cmf = anterior decussation of fibres.
Th = division of fibres.



12.

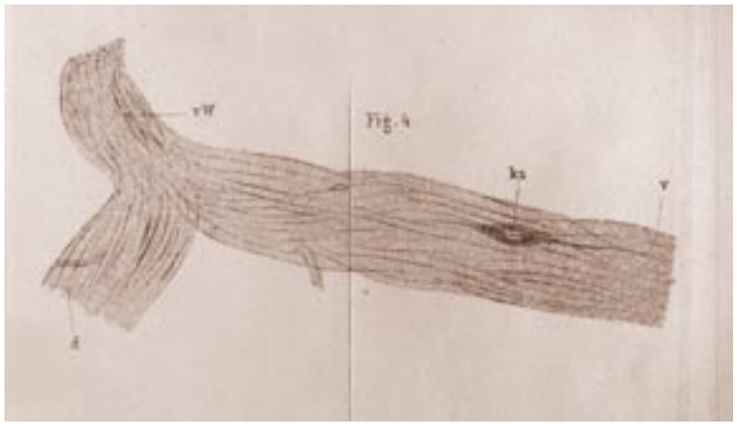
Freud's original drawing (bottom) for the published illustration (top). Ink on paper. Freud Museum, London.

12. "Über Spinalganglien und Rückenmark der Petromyzon" (On the Spinal Ganglia and Spinal Cord of Petromyzon), *Sitzungsberichte der Mathematisch-Naturwissenschaftlichen Classe der Kaiserlichen Akademie der Wissenschaften,* LXXVIII. Band. I. Abtheilung (1878). The New York Academy of Medicine.

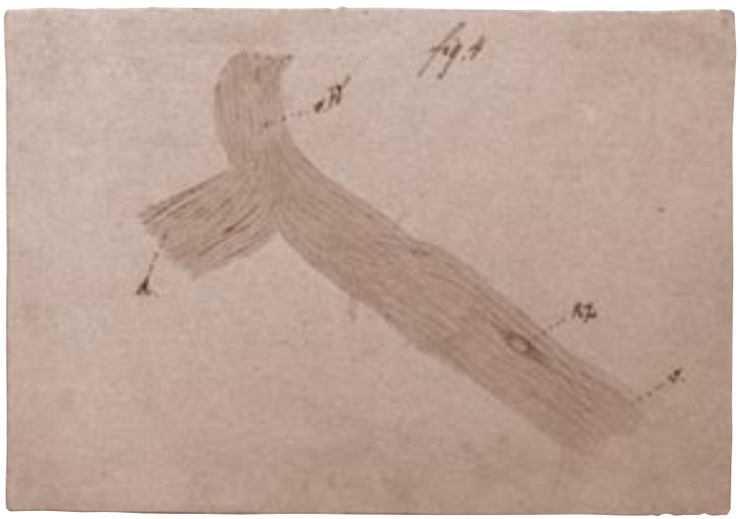
Plate II

Fig. 3. A posterior root with superficial posterior cell on *pia mater.* Alcohol carmine preparation. Magnification 220.

HW = posterior root.
zf = cell fibre.
ohz = superficial posterior cell.
auf.f = ascending fibre.



13.

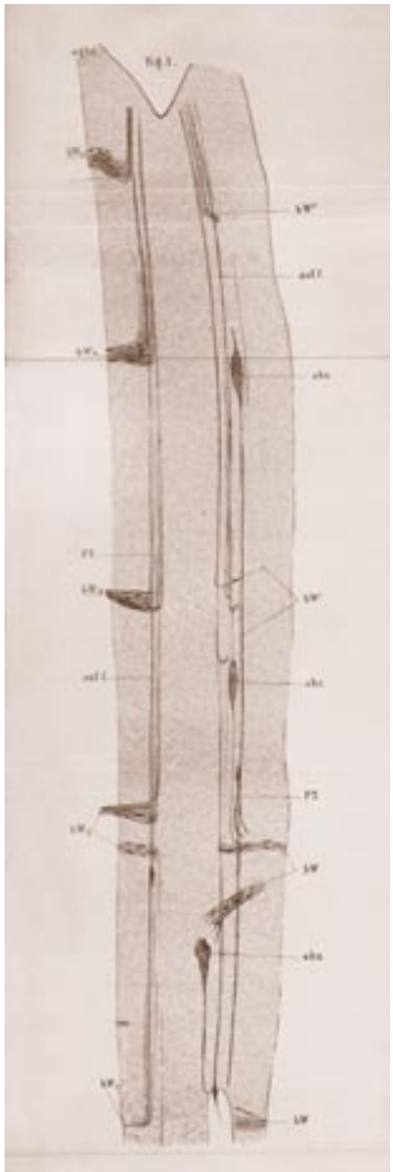


Freud's original drawing (bottom) for the published illustration (top). Ink on paper. Freud Museum, London.

13. "Über Spinalganglien und Rückenmark der Petromyzon" (On the Spinal Ganglia and Spinal Cord of Petromyzon), *Sitzungsberichte der Mathematisch-Naturwissenschaftlichen Classe der Kaiserlichen Akademie der Wissenschaften,* LXXVIII. Band. I. Abtheilung (1878). The New York Academy of Medicine.

Plate II

Fig. 4. Anterior root, gold stain, magnification 285.
aW = anterior root.
d = dorsal branch.
v = ventral branch.
kz = small interposed cell.



14.

14. “Über Spinalganglien und Rückenmark der Petromyzon” (On the Spinal Ganglia and Spinal Cord of Petromyzon), *Sitzungsberichte der Mathematisch-Naturwissenschaftlichen Classe der Kaiserlichen Akademie der Wissenschaften,* LXXVIII. Band. I. Abtheilung (1878). The New York Academy of Medicine.

Plate III

Fig. 1. Flat slice of pia mater with five posterior roots, the superficial fibres and posterior cells. Chromic acid preparation, gold stain. Magnification 50. At *hW*2, hW and *hW* two half-roots in place of a single one.

*hw*1 - *hw*5 = posterior roots.
ohz = superficial posterior cell.
auff = ascending fibres.
qhz = posterior cell lying in the root.
FZ = fibres joining in the course of ascending fibres.

15.

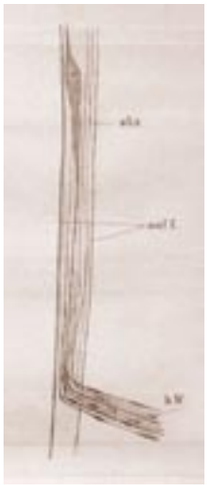
Freud's original drawing (bottom) for the published illustration (top). Ink on paper. Freud Museum, London.

15. "Über Spinalganglien und Rückenmark der Petromyzon" (On the Spinal Ganglia and Spinal Cord of Petromyzon), *Sitzungsberichte der Mathematisch-Naturwissenschaftlichen Classe der Kaiserlichen Akademie der Wissenschaften,* LXXVIII. Band. I. Abtheilung (1878). The New York Academy of Medicine.

Plate III

Fig. 2. Flat slice (frontal) through pia mater and surrounding tissues. Chromic acid preparation, gold stain. Magnification 105. Cells lying in the transverse course of root *qhz* and *qhz.*

sz G = so-called bone-forming tissue round the vertebral canal.
D = dura mater.
Ar = arachnoidal space.
Spg = spinal ganglion.
G = cross-section of vessel.
M = muscle.
hW = posterior root.
U = bend of posterior root fibres in the spinal cord.
vW = anterior root.
Gf = vessel.
qhz = transverse posterior cells lying in the root.



16a.

16b.

Freud's original drawing (right) for the published illustrations (left). Ink on paper. Freud Museum, London.

16. "Über Spinalganglien und Rückenmark der Petromyzon" (On the Spinal Ganglia and Spinal Cord of Petromyzon), *Sitzungsberichte der Mathematisch-Naturwissenschaftlichen Classe der Kaiserlichen Akademie der Wissenschaften,* LXXVIII. Band. I. Abtheilung (1878). The New York Academy of Medicine.

Plate III

Fig. 3. Posterior root with ascending fibre and superficial posterior cell from a flat slice of pia mater. Chromic acid-gold preparation. Magnification 110.

hW = posterior root
auff = ascending fibres from a previous root.
ohz = superficial posterior cell.

Fig. 4. Isolated superficial posterior cell on pia mater. Chromic acid-gold preparation. Magnification 110.

ohz = superficial posterior cell.
zf = its root process.
hw = its bending to posterior root.
c = central process.

17.

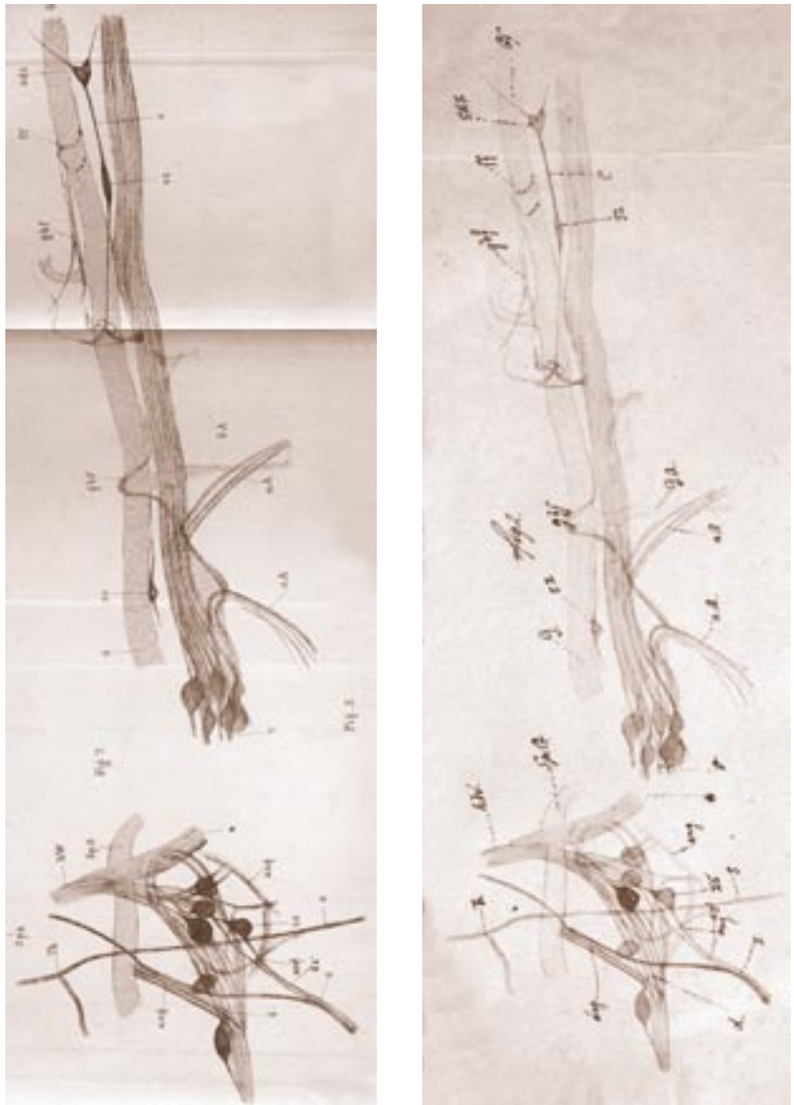
Freud's original drawing (right) for the published illustration (left). Ink on paper. Freud Museum, London.

17. "Über Spinalganglien und Rückenmark der Petromyzon" (On the Spinal Ganglia and Spinal Cord of Petromyzon), *Sitzungsberichte der Mathematisch-Naturwissenschaftlichen Classe der Kaiserlichen Akademie der Wissenschaften,* LXXVIII. Band. I. Abtheilung (1878). The New York Academy of Medicine.

Plate IV

Fig. 1. A posterior root's ventral branch with accompanying vessel. One fibre accompanying the vessel *gbf* can be followed into the ventral branch of the posterior root. Gold stain. Magnification 225.

spz = most exterior spinal ganglion cell.
vA = ventral branch.
sz = sympathetic cell.
ez = small cell lying in the ventral branch.
aA = small branch exiting ventral branch.
gbf = fibre accompanying vessel.
z = branch of fibre accompanying vessel.
ff = thin varicose fibre into which the fibre accompanying the vessel merges.



18.

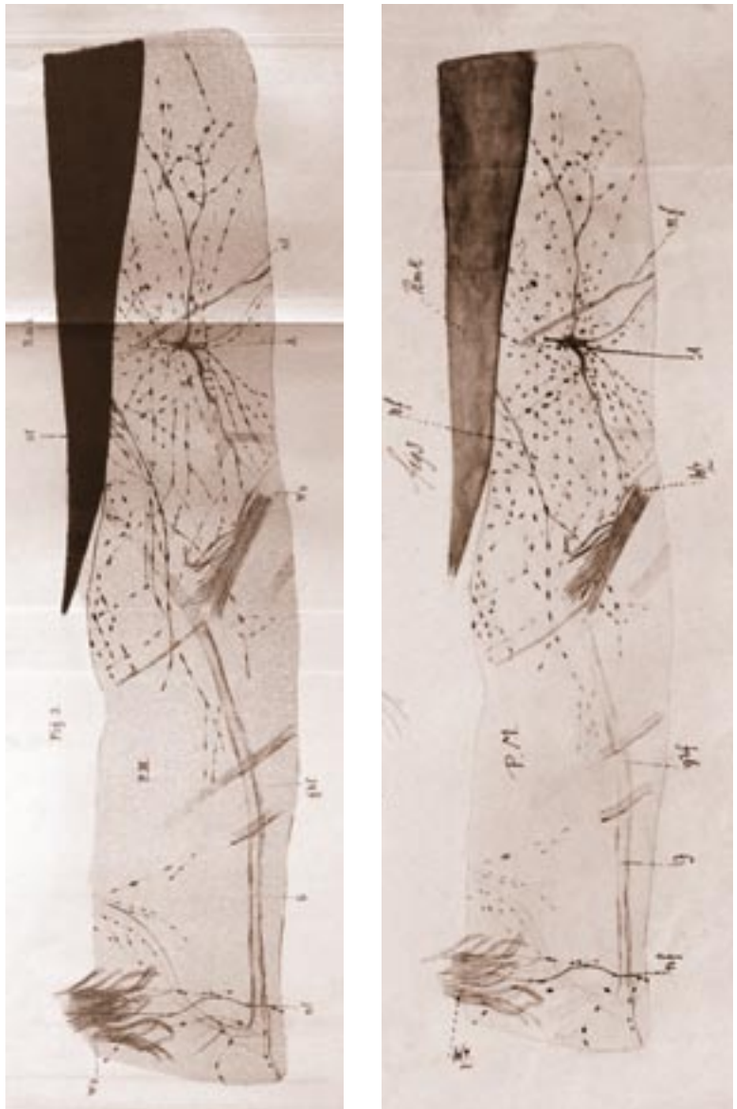
Freud's original drawing (right) for the published illustrations (left). Ink on paper. Freud Museum, London.

18. "Über Spinalganglien und Rückenmark der Petromyzon" (On the Spinal Ganglia and Spinal Cord of Petromyzon), *Sitzungsberichte der Mathematisch-Naturwissenschaftlichen Classe der Kaiserlichen Akademie der Wissenschaften,* LXXVIII. Band. I. Abtheilung (1878). The New York Academy of Medicine.

Plate IV

Fig. 2. Spinal ganglion, ventral branch of the posterior root and accompanying vessel. The ventral branch torn before ventral cells enter it. At *C* a commissure between two cells. Gold stain. Magnification 225.

SpG = spinal vessel.
d = dorsal branch.
v = ventral branch.
s = sympathetic branch.
ang = anaclitic fibre.
dz = through-going fibre entering sympathetic branch.
Th = division of a fibre crossing the dorsal branch.
aA = branches exiting the ventral branch.
sz = sympathetic cell.
sdz = sympathetic double cell.
GA = branches of vessel.
zs = spinal ganglion cell emitting its process into the sympathetic branch.



19.

Freud's original drawing (right) for the published illustration (left). Ink on paper. Freud Museum, London.

19. "Über Spinalganglien und Rückenmark der Petromyzon" (On the Spinal Ganglia and Spinal Cord of Petromyzon), *Sitzungsberichte der Mathematisch-Naturwissenschaftlichen Classe der Kaiserlichen Akademie der Wissenschaften,* LXXVIII. Band. I. Abtheilung (1878). The New York Academy of Medicine.

Plate IV

Fig. 3. Fine network of varicose fibres on the pia mater. Gold stain. Magnification 185.

PM = pia mater.
Rmk = spinal cord.
Wz = root.
G = vessel in the pia meter.
nf = nerve-fibres which merge into the net of varicose fibres.
A = a point from which the ramifying nerve fibres and the varicose fibres radiate.

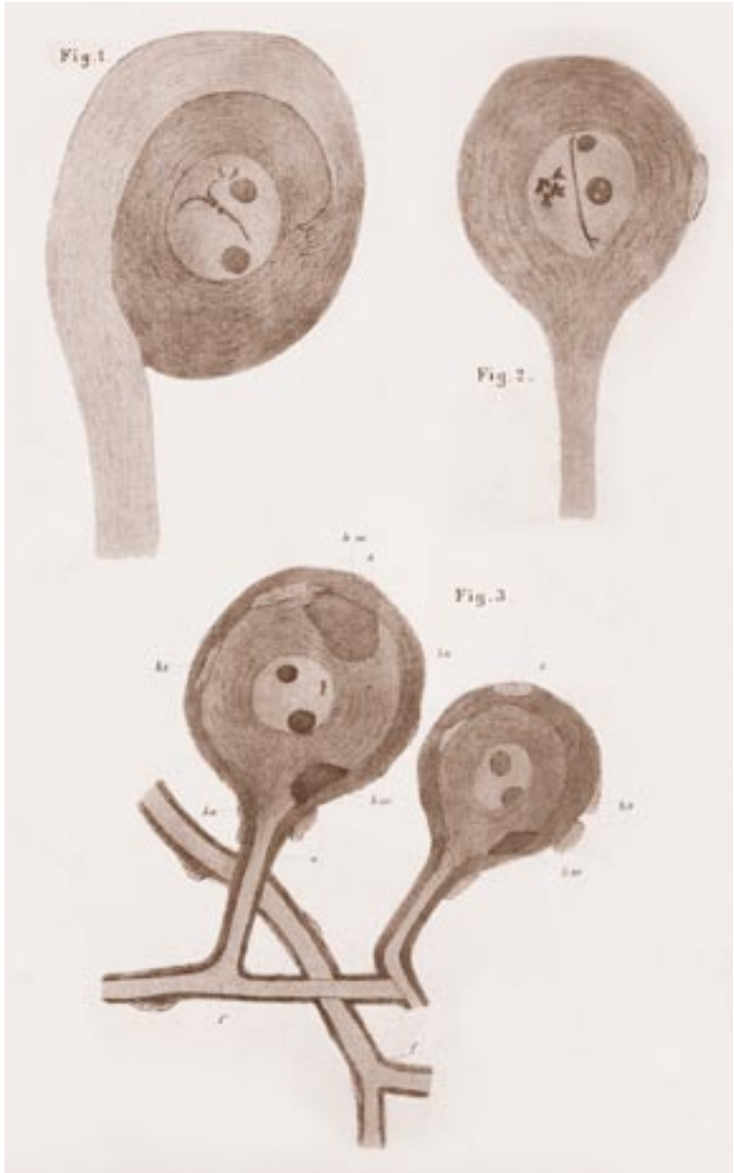
Comment:

By researching the *genetic migration and transformation* of nerve cells in the spinal cord of Petromyzon (the same lowly species studied in the previous paper), Freud was able to show that a continuous series of subtle changes linked the nervous systems of invertebrates and vertebrates. Previously it was believed that a sharp anatomical division separated these two classes of animal. In other words, Freud discovered something of a "missing link" in this study. He thereby contributed to the great pool of data which finally established in the scientific community the conviction of the evolutionary continuity of all organisms.

Freud also showed in these drawings that along the path originally traversed by its cells through the evolution of the species, some primitive forms had remained behind in the spinal cord of the contemporary animal – fixated, as it were – in their phylogenetic development. We may therefore trace back to these drawings Freud's abiding belief in the *persistence of primitive structures* in the fully developed organism. This connection is underscored by the fact that he later referred to this study when illustrating the concept of fixation in his *Introductory Lectures on Psychoanalysis* (1916-17).

There he wrote:

> ". . . it is possible in the case of every particular sexual trend that some portions of it have stayed behind at earlier stages of its development, even though other portions may have reached their final goal."
>
> We note also, in the legend to these drawings, Freud's first use of the word "anaclytic" – to describe a type of nerve fiber which attaches itself to another fiber that originates in a nerve cell, but is itself independent of that cell.



20.

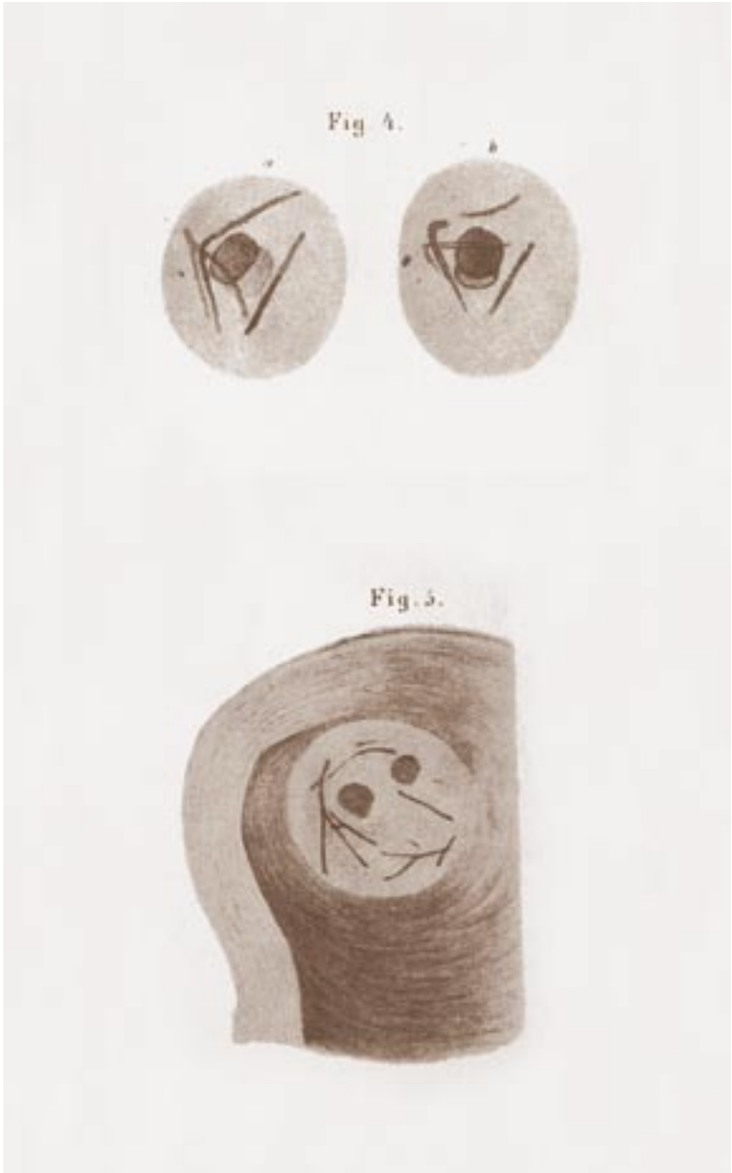
20. "Über den Bau der Nervenfasern und Nervenzellen beim Flusskrebs" (On the Structure of the Nerve Fibers and Nerve Cells of the River Crayfish), *Sitzungsberichte der Mathematisch-Naturwissenschaftlichen Classe der Kaiserlichen Akademie der Wissenschaften*, LXXXV. Band. III. Abtheilung (1882). The New York Academy of Medicine.

Fig. 1. Nerve cell from the tail ganglion of the river crayfish with a process which clings to the surface of the cell. The nucleus contains, apart from the round nucleoli, several short, thick rods and a nuclear body consisting of two pieces. Drawn with Hartnack 3/8, magnification 360.

Fig. 2. Living nerve cell from an abdominal ganglion with coniform process. The nucleus, which is without a membrane, contains four small particles with multiple peaks and a rod bent at its end and forked. At *k* a nucleus of the covering tissue. Same magnification as Fig. 1.

Fig. 3. Marginal portion of the spindle-shaped gastric ganglion of the river crayfish. Two multipolar nerve cells with their processes, one of which displays a T-shaped partititon. The smaller cell has been drawn with an adjustment near to the surface.

s = thick, concentrically stratified cell-sheath.
ks = nuclei of the above.
hm = strongly shining homogeneous masses at the margin of the cell, but situated interiorly from the cover.
f = fibre from another cell.



21.

21. "Über den Bau der Nervenfasern und Nervenzellen beim Flusskrebs" (On the structure of the Nerve Fibers and Nerve Cells of the River Crayfish), in *Sitzungsberichte der Mathematisch-Naturwissenschaftlichen Classe der Kaiserlichen Akademie der Wissenschaften,* LXXXV. Band. III. Abtheilung (1882). The New York Academy of Medicine.

Fig. 4. Nucleus of a large nerve cell. This nucleus displayed movement in both neucleoli. *b* was drawn five minutes after *a*. Hartnack 3/8. Magnification of the drawing 400.

Fig. 5. Portion of a cell with process as in Fig. 1. In the nucleus a large number of delicate, forked and bent rods. Same magnification as in Fig. 4.

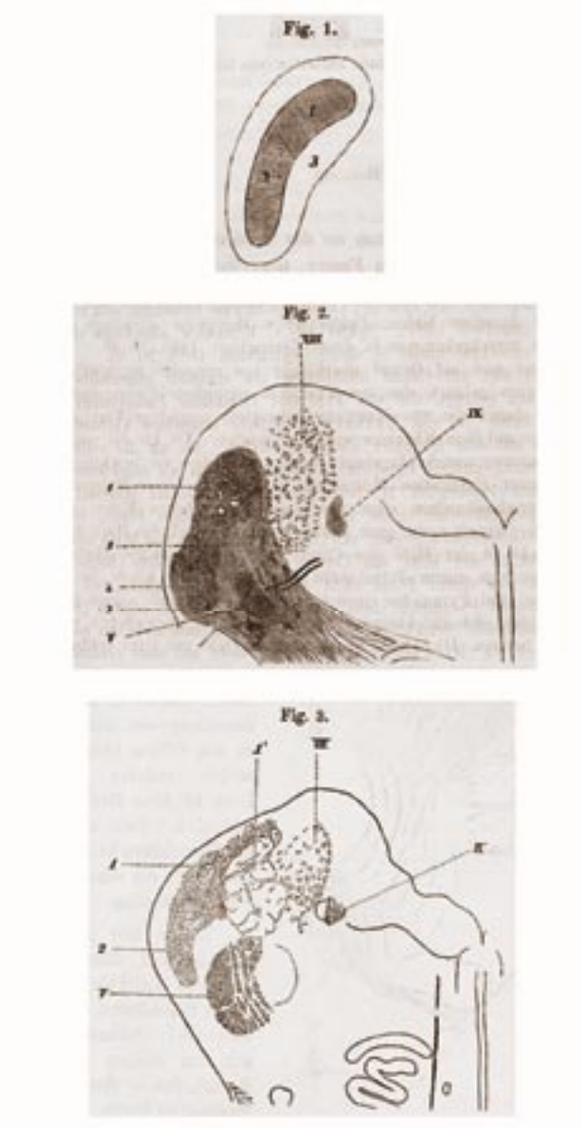
Comment:

At the time that Freud conducted this study the structural and functional relations of nerve cells and fibers were still highly controversial. In these drawings Freud depicted the essential unity of cell and fiber. This paved the way for the *neuron doctrine*. Unfortunately the way in which Freud presented his conclusions was too cautious and reserved for him to actually be credited with the discovery of the neuron – and a full seven years would pass before Wilhelm von Waldeyer-Hartz and Santiago Ramón y Cajal formally proclaimed its existence. Nevertheless, in R. Shepherd's *Foundations of the Neuron Doctrine* (Oxford: Oxford University Press, 1991), an entire chapter is devoted to Freud's contributions. M. Brazier, in her standard 1959 work on the history of neurophysiology, also credits Freud with adumbrating Sherrington's concept of the synapse ("The historical development of neurophysiology," in J. Field, H. Magoun, H. Hall and V. Hall (eds.), *Handbook of Physiology: Section 1, Neurophysiology,* vol. 1 (Washington, D.C.: American Physiological Society)). It therefore seems ironic that years later, when Freud turned his scientific attention to problems of psychology, he was widely accused of leaping too quickly from observation to theory.

A decade after Freud published these drawings, when he built an elaborate model of the mind around the concept of the neuron, in

his 1895 *Project for a Scientific Psychology* (see Plates 31-33), there was no hint of the fact – which must by then have been clear to him – that he actually played a seminal role in the development of that concept.

In the legend to one the drawings shown here (Fig. 2) Freud mentioned that the cell he depicted was *alive*. He was dissatisfied with the standard technique of observing dead cells under the microscope. His new technique enabled him to directly observe the internal workings of the living cell. A host of structures and processes which had previously been invisible thus suddenly appeared before him. As L. Triarho and M. del Cerro confirm in their 1985 study ("Freud's Contributions to Neuroanatomy," *Archives of Neurology*, 42: 282), this enabled Freud to provide an early account of microtubules (before microtubules were actually discovered) and to unwittingly become the first scientist to report the phenomenon of nuclear rotation of neurons in culture (see legend to Fig. 4). With this new technique, Freud grasped the fact, so important for his later work, that progress in science flows from new methods of observation.



22.

22. "Über die Beziehung des Strickkörpers zum Hinterstrang und Hinterstrangskern, nebst Bemerkungen über zwei Felder der Oblongata" (On the Relationship of the Restiform Body to the Posterior Column Nucleus with Observations on Two Fields of the Oblongata**),** *Neurologisches Zentralblatt.* Band 5 (1886). The New York Academy of Medicine.

Fig. 1. Schema of the restiform body at the lower levels of the auditory nerve.

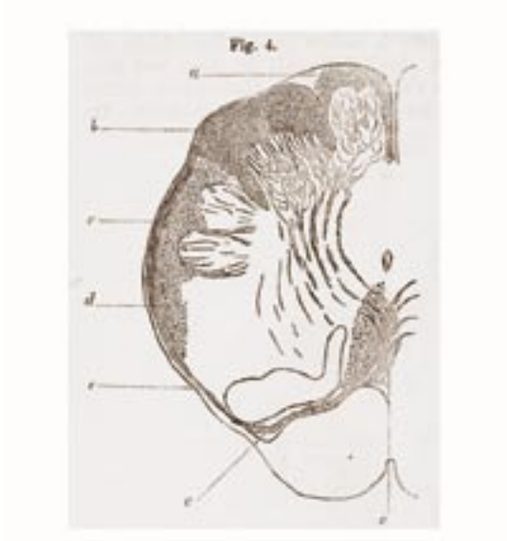
1. Head of the primary restiform body.
2. Tail of the primary restiform body.
3. Poorly myelinated fringe (secondary restiform body).

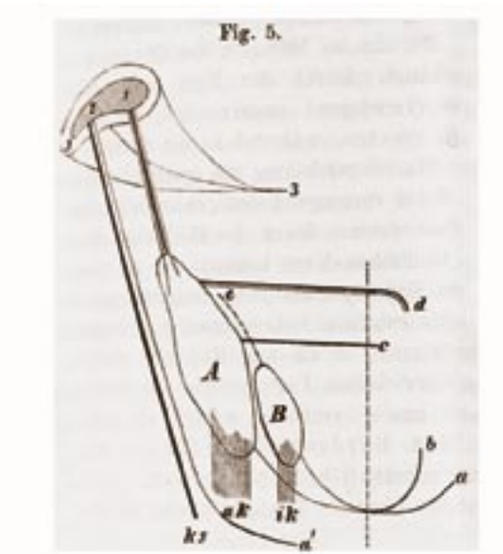
Fig. 2. Transverse section at the upper levels of Deiters's nucleus (Series II).

1. Head of the primary restiform body in which small particles of grey substance appear (drawn as visualized in deeper planes).
2. Its tail.
3. Secondary restiform body (olivary system) beginning to separate.

V. Ascending trigeminal root.
VIII. Deiters's nucleus with the ascending auditory root (Roller).
IX. Ascending root of the vagal system.

Fig. 3. Transverse section at the upper level of Deiters's nucleus (Series II). The numbering is the same as in Fig. 2. The place of the head has been occupied by nucleus 1.





23.

23. "Über die Beziehung des Strickkörpers zum Hinterstrang und Hinterstrangskern, nebst Bemerkungen über zwei Felder der Oblongata" (On the Relationship of the Restiform Body to the Posterior Column Nucleus with Observations on Two Fields of the Oblongata), *Neurologisches Zentralblatt.* Band 5 (1886). The New York Academy of Medicine.

Fig. 4. Transverse section through the "superior pyramidal decussation" (Series II):

a = Residue of Goll's column.
b = Residue of Burdach's column.
c, c, c = Fibres leading from the superior pyramidal decussation to the restiform body.
d = Lateral cerebellar tract.
e = Superior pyramidal (lemniscal decussation).

Fig. 5. Schematic representation of the posterior column nucleus and its connexions.

A = Burdach's nucleus.
B = Goll's nucleus.
1 = Head of the primary restiform body.
2 = Tail of the above.
3 = Secondary restiform body (olivary system)
a = Fibre leading from the inferior arcuate fibre system to the contralateral restiform body.
b = Inferior arcuate fibre system (superior pyramidal decussation) leading to inter-olivary layer.
c = Middle arcuate fibre system.
d = Superior arcuate fibre system.
e = Fibres from Goll's tract (fibrae arcuatae externae).
Ks = Lateral cerebellar tract.
aK = External cuneiform tract (fibres from the arm).
iK = Internal cuneiform tract (fibres from the leg).

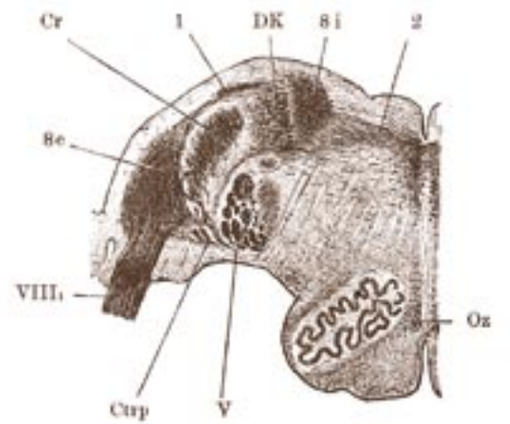
Comment:

In this and the next study, Freud progressed from the spinal cord upwards to the *brain* itself, and also from the individual nerve

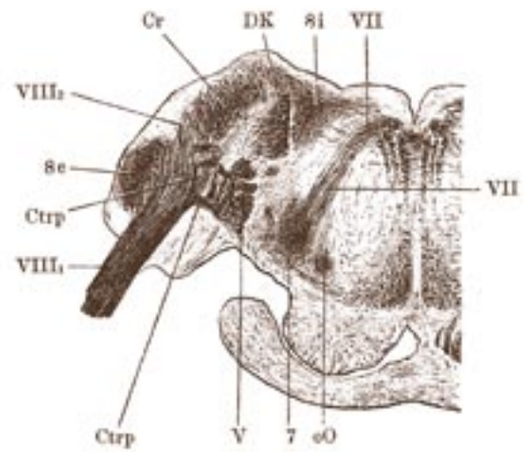
cell to cell *groups* (and the pathways that link them). He simultaneously shifted from the animal to the *human* nervous system. In these drawings Freud and his co-author, L. O. von Darkschewitsch, demonstrated the existence of links between the posterior spinal columns and the cerebellum in the restiform body. It is hard to imagine nowadays, when medical students simply learn the anatomy of the brainstem from textbooks, that barely 100 years ago pioneers like Freud were laboriously identifying structures and connections in this tiny but highly complex part of the nervous system.

In this work, Freud's methodology was again interesting. Instead of attempting to directly map the masses of fiber-paths within this densely compacted part of the adult brain, he studied the much simpler patterns that can be more easily visualized in the fetal and infantile brain. Then, he methodically traced the later developments across increasingly more mature specimens. Once more, Freud's commitment to evolutionary and *developmental* ways of thinking is apparent.

Figur I.



Figur II.



24.

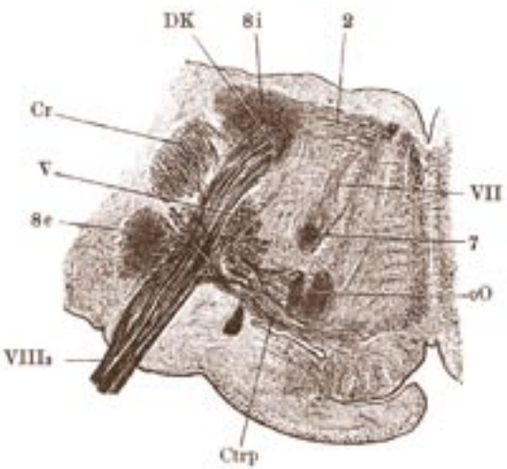
24. "Über den Ursprung des Nervus acusticus" (On the Origin of the Nervus Acusticus), *Monatsschrift für Ohrenheilkunde sowie für Kehlkopf-, Nasen-, Rachen-Krankheiten. (Neue Folge)* vol. XX, no. 8 (1886), Figs. 1-2. Collection of Bruce Sklarew, MD, Chevy Chase, Maryland.

Fig. I. Section through the most inferior level of the origin of the acusticus from a human foetus of 6 months. treated with Weigert's haematoxyline:

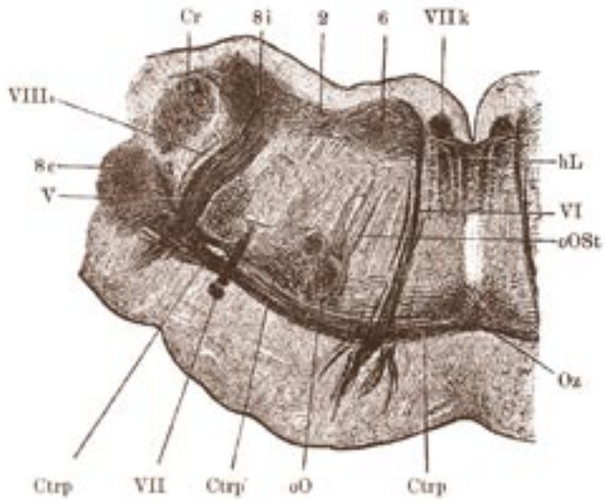
VIII1 = The first portion of the auditory nerve.
8e, 8i = External and internal nucleus of the acusticus.
DK = Deiters's nucleus.
V = Cross-section through [nervus] quintus.
Cr = Corpus restiforme.
Oz = Inter-olivary layer.
1 = Acusticus fibres surrounding the restiform body.
2 = Fibres from *8i* leading to the raphe.
Ctrp = Corpus trapezoides.

Fig. II. Higher section from the same series. Here the nucleus of the facialis 7 is also visible, as are the root fibres of this nerve VII running to the genu of the [nervus] facialis. VIII2 denotes the second portion of the acusticus, running around and through the restiform body; O is the upper olive. The remainder of the legend as in Fig. I.

Figur III



Figur IV.



25.

25. "Über den Ursprung des Nervus acusticus" (On the Origin of the Nervus Acustiicus), *Monatsschrift für Ohrenheilkunde sowie für Kehlkopf-, Nasen-, Rachen-Krankheiten. (Neue Folge)* vol. XX, no. 8 (1886), Figs. 3-4. Collection of Bruce Sklarew, MD, Chevy Chase, Maryland.

Fig. III illustrates the transition of the third portion of the acusticus *VIII3* into the fibres of Deiters's nucleus [*DK*]. All markings as before.

Fig. IV. Section through the level of the fourth portion of the acusticus and of the nucleus of the n[ervus] abducens (*6*). *VI* is the n[ervus] abducens, *hL* the posterior longitudinal tracts, *VIIk* the genu of the facialis, *Ctrp* the part of the corpus trapezoides which proceeds to the ipsilateral upper olive, *OST* stem of the upper olive. Other markings as before.

26.

26. "Über den Ursprung des Nervus acusticus" (On the Origin of the Nervus Acustiicus), *Monatsschrift für Ohrenheilkunde sowie für Kehlkopf-, Nasen-, Rachen-Krankheiten. (Neue Folge)* vol. XX, no. 9 (1886), Fig. 5. Collection of Bruce Sklarew, MD, Chevy Chase, Maryland.

Fig. V. Schematic diagram of the origin of the acusticus:

I = The first portion, which terminates in the acusticus ganglion *8e*.

II = The third portion, which proceed into the fibres of Deiters's nucleus.

III = The second and fourth portions of the nerve, which terminate in the interior acusticus field (*8i*). Central projections:

Ctrp = Corpus trapezoides.

1 =Fibres which connect the exterior with the interior nucleus.

2 = Fibres from 8i to the raphe.

3 = Arcuate fibres from 8i to the contralateral roof nucleus of the cerebellum.

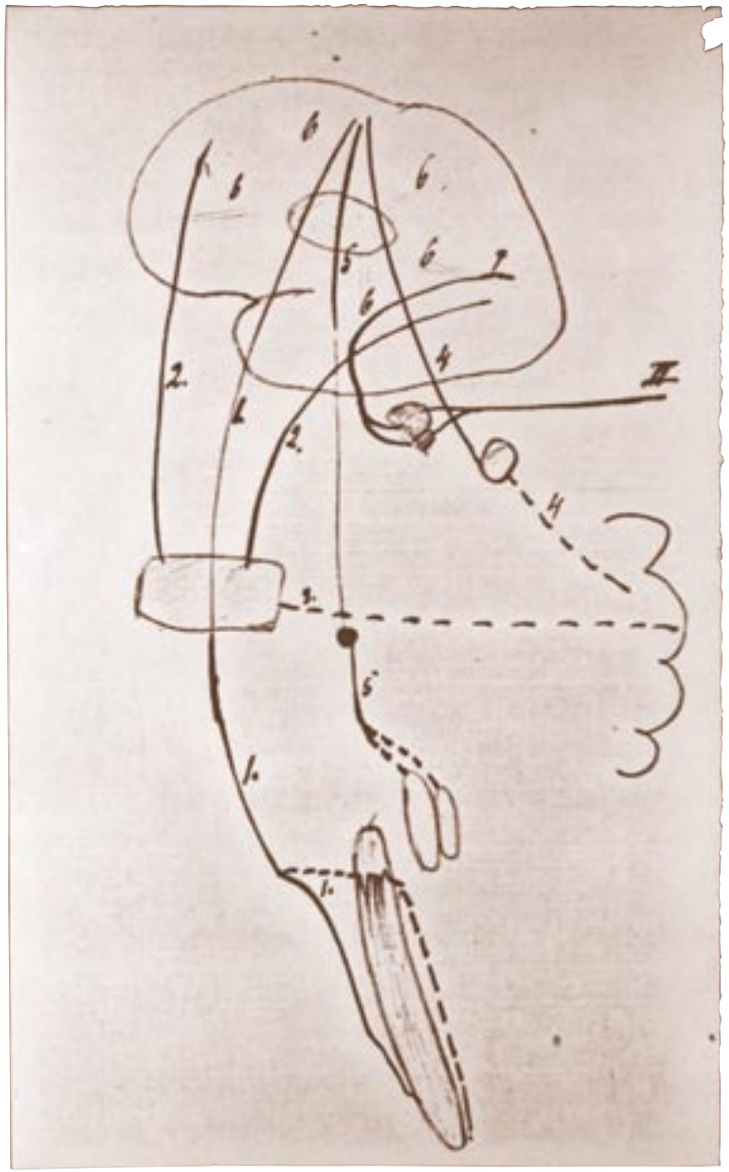
Comment:

In these drawings, Freud traced the origin and connections of the auditory nerve in the human medulla oblongata. Again, he studied fetal specimens (see legend to Fig. I). On the basis of his findings, Freud formulated the theory that the sensory cranial nerve nuclei are homologous with the posterior nerve roots of the cord. He thus brought simple order to a once-chaotic and opaque region of the brain. This was Freud's last *primary* anatomical research paper. From this point onward, his anatomical writings become increasingly abstract and *theoretical*.

Many years later, in *New Introductory Lectures on Psychoanalysis* (1933), looking back on this period of his work through the lens of psychoanalysis, Freud wrote:

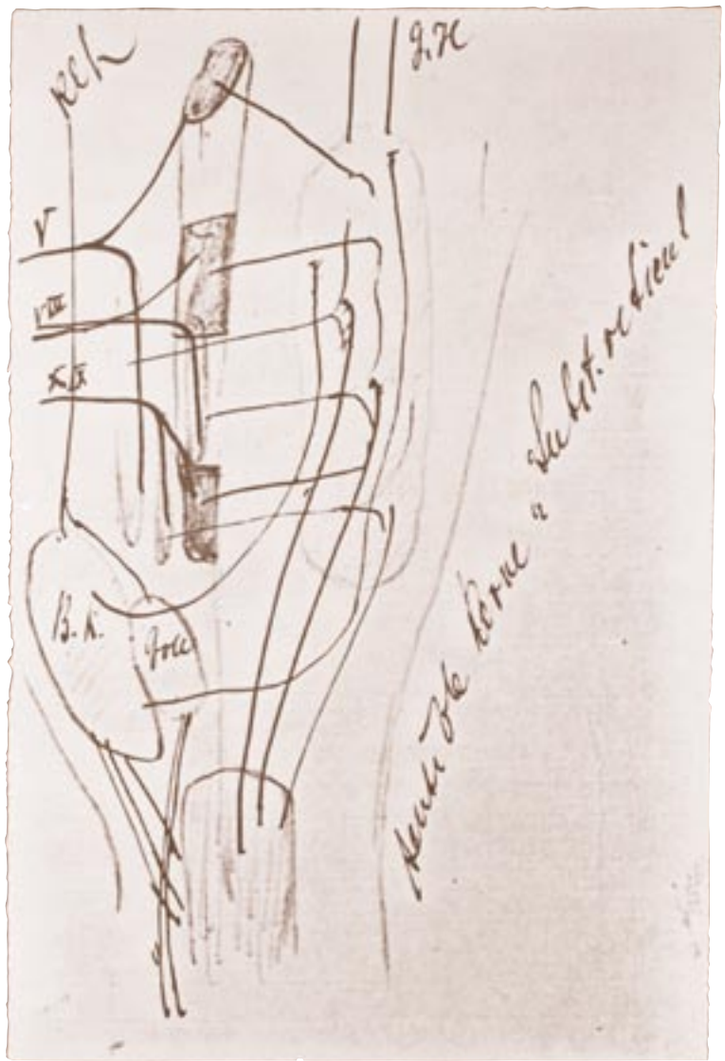
> "You will certainly expect psychoanalysis to approach [the subject of anxiety] in quite a different way from academic medicine. Interest there seems mainly to be centerd on the anatomical paths along which the state of anxiety is brought

about. We are told that the medulla oblongata is stimulated, and the patient learns that he is suffering from a neurosis of the vagus nerve. The medulla oblongata is a very serious and lovely object. I remember quite clearly how much time and trouble I devoted to its study many years ago. Today, however, I must remark that I know of nothing that could be of less interest to me for the psychological understanding of anxiety than knowledge of the path of the nerves along which its excitations pass."



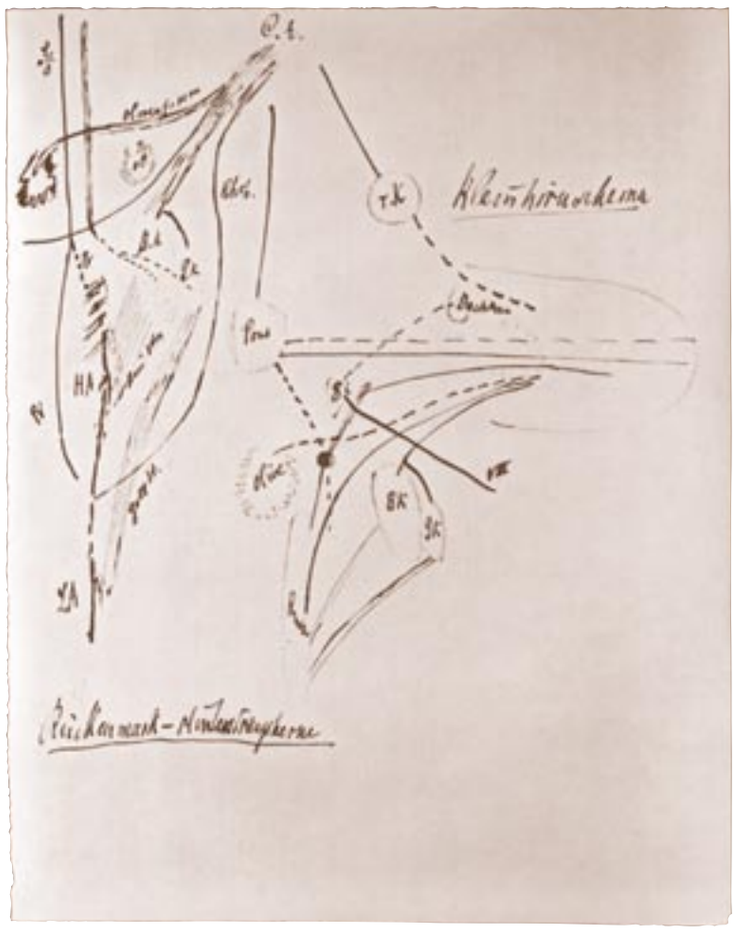
27.

27. *Einleitung in die Nervenpathologie* (Introduction to Neuropathology) (c. 1886), Fig. 1. Sigmund Freud Collection, Library of Congress.



28.

28. *Einleitung in die Nervenpathologie* (Introduction to Neuropathology) (c. 1886), Fig. 2. Sigmund Freud Collection, Library of Congress.



29.

29. *Einleitung in die Nervenpathologie* (Introduction to Neuropathology) (c. 1886), Fig. 3. Sigmund Freud Collection, Library of Congress.

Comment:

These rough drawings in the unpublished manuscript *Einleitung in die Nervenpathologie* (Introduction to Neuropathology, circa 1886) represent the culmination of Freud's theoretical contributions to neuroanatomy. They were sketched for an unpublished manuscript that he wrote shortly after his period of study in Paris with Jean-Martin Charcot. In this manuscript, Freud provided a succinct overview of the general structure of the human nervous system. The overview included novel concepts which laid the foundations for his later work. The most important novelty was the idea that *the body periphery is not projected onto the cortex in a simple and direct fashion*, as Freud's teacher Theodor Meynert had supposed it was, but rather it is *represented* there. In other words, the relationship between body and cortex is not topological but *functional*. This important concept was restated in Freud's 1891 aphasia monograph as follows:

> "The fibres that reach the cerebral cortex after their progression through [spinal and subcortical nuclei] still maintain some relationship with the periphery of the body, but they can no longer deliver an image that resembles it topologically. They contain the body periphery in the same way as a poem contains the alphabet, in a complete rearrangement, serving different purposes, with manifold links between the individual elements, whereby some of them may be rendered several times, others not at all.… Topographic relations are only maintained in so far as they fit in with the claims of function."

It is no exaggeration to say that this insight is the precise point at which the *mind* – that aspect of the organism which represents the body not concretely but rather *functionally, abstractly and symbolically* – entered Freud's scientific work. The concept is explicitly repeated in Freud's 1893 study on "Organic and hysterical paralysis," where he famously stated that hysterical paralyses do not represent the body in a topologically correct fashion; rather, they are "lesions of ideas" (i.e., of functional representations). The same concept was

repeated explicitly again in a letter to Fliess dated December 6, 1896 (see Plate 39) and as we shall see, it then became the basis of Freud's first truly psychoanalytic model of the mind (Plate 40).

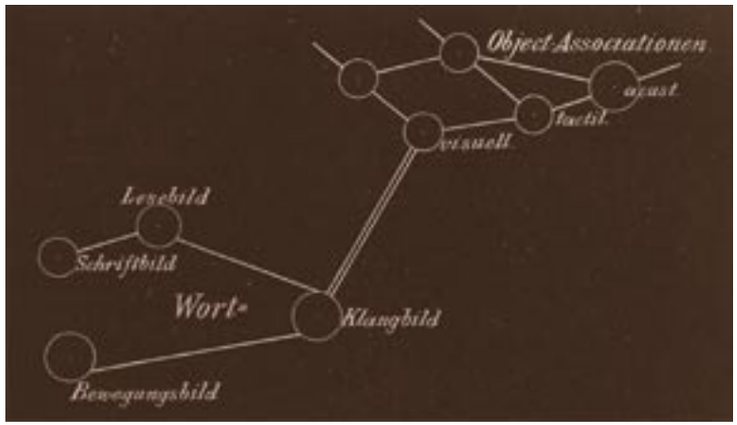


Fig. 8

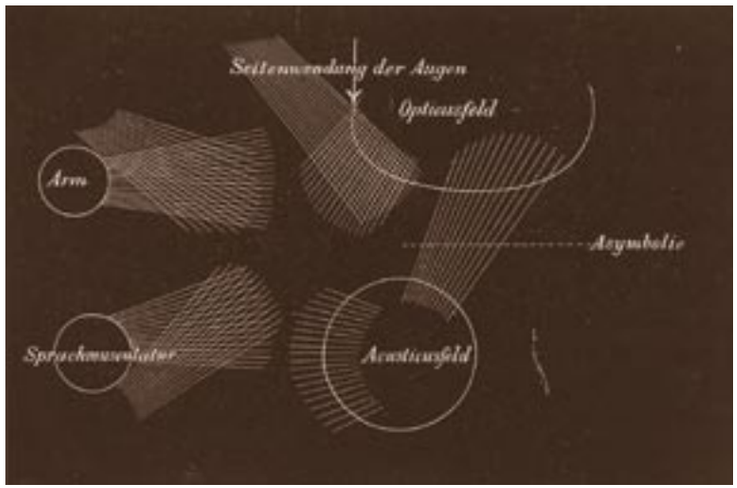


Fig. 9

30.

30. *Zur Auffassung der Aphasien* (On Aphasia) (Leipzig, Wien: Franz Deuticke, 1891). Figs. 8 and 9. Collection of Bruce Sklarew, MD, Chevy Chase, Maryland.

Fig. 8. Psychological diagram of the word presentation.

The word presentation is shown as a closed complex of presentations, whereas the object presentation is shown as an open one. The word presentation is not linked to the object presentation by all its constituent elements, but only by its sound image. Among the object associations, it is the visual ones which stand for the object, in the same way as the sound image stands for the word. The connections linking the word sound image with object associations other than the visual ones are not indicated.

Fig. 9. Anatomical diagram of the language association field

Explaining the appearance of language centers. The cortical fields of the acusticus, opticus, arm and articulatory musculature are depicted diagramatically by circles; the association pathways reaching from there into the interior of the language field are represented by radiating clusters. The points at which the latter are crossed by clusters which have been disconnected from their [contralateral] regions of origin become "centers" for the associative elements in question. The bilateral connections of the acusticus field have not been indicated, partly to prevent the figure becoming confusing and partly due to the uncertainty that surrounds precisely this relationship between the auditory field and the auditory language center. The spatial division of the connections with the opticus field into two bundles also allows for the consideration that eye movements are enlisted in a special way in reading associations.

Comment:

Having detached himself from a concretely anatomical way of thinking by entering the realm of functional representations, Freud turned his attention to the field of neuro*psychology*. He started with the problem of how language is organized in the brain. Fig. 8 is Freud's first drawing of a purely psychological entity: the 'word presentation" (contrasted with "object presentations"). Students of

psychoanalysis will recognize these theoretical entities, which continued to play an important role in Freud's later conceptualizations of the mind and its workings.

The special role assigned to the "sound image" in this drawing also persisted in Freud's later writings. Consider the following passage from *The Ego and the Id* (1923):

> "Verbal residues are derived primarily from auditory perceptions, so that the system *Pcs.* has, as it were, a special sensory source. The visual components of word-presentations . . . may to begin with be left on one side; so may the motor images of words. . . . In essence a word is after all the mnemic residue of a word that has been heard."

Freud believed that the auditory origin of language gave it the concrete, perceptual quality that was necessary for associations to become *conscious.* It could be said, therefore, that this drawing introduced the fundamental conceptual basis of the "talking cure," namely the mechanism by which unconscious processes may be rendered conscious.

Freud also accorded a special role to the auditory element of language in his conceptualization of the genesis of the *superego* (*The Ego and the Id,* 1923), and the processes by which internal superego activities become conscious thoughts or hallucinations.

Fig. 9 purports to be an anatomical diagram, to complement the psychological schema depicted in Fig. 8; but comparing it with Freud's earlier anatomical drawings, it is apparent that it really is a functional diagram. Freud would never again concern himself with the concrete structure of the brain. Henceforth his approach was always *functional* and *dynamic.* Consider the following passage from *The Interpretation of Dreams* in the light of this drawing:

> "Ideas, thoughts and psychical structures in general must never be regarded as localized *in* organic elements of the nervous system but rather, as one might say, *between* them, where resistances and facilitations provide the corresponding correlates. Everything that can be an object of our internal perception is *virtual,* like the image produced in a telescope by the passage of light-rays."

31.

31. Diagram of areas in which damage produces major languages disorders, in *Diagnostisches Lexikon für praktische Ärzte*. Band 1. Berlin, Wien, Urban and Schwarzenberg (1893).

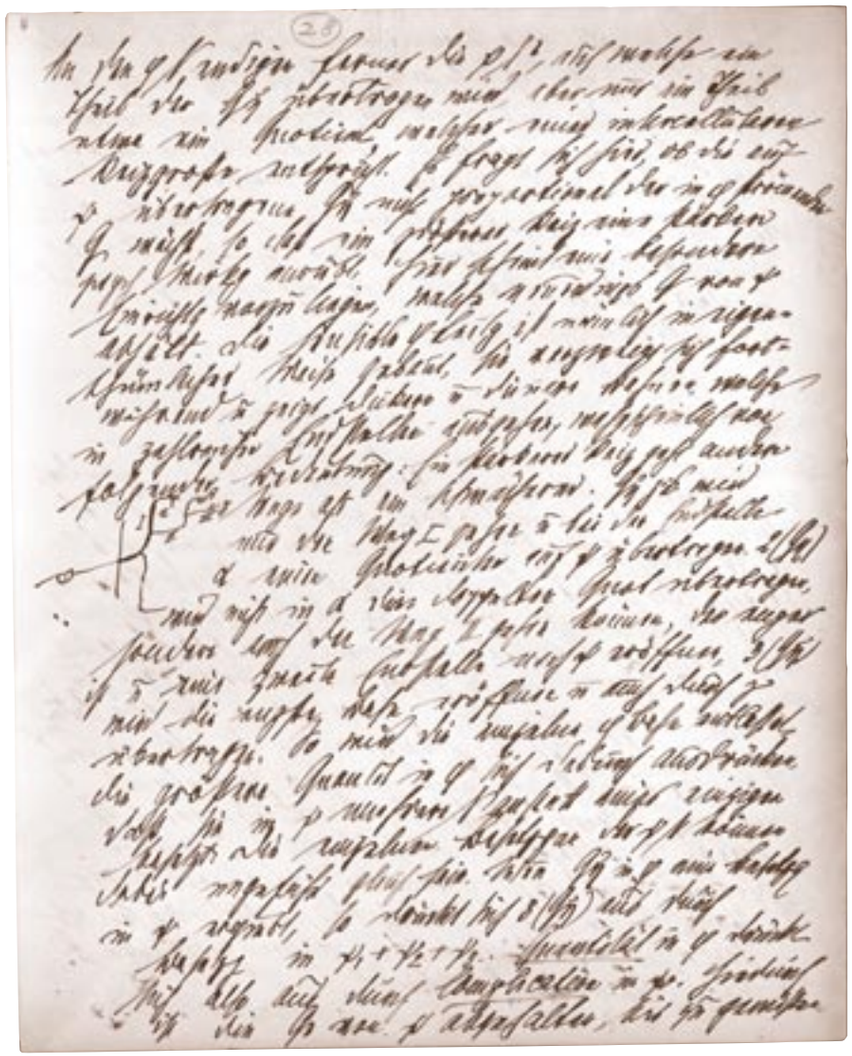
The hatched areas correspond to the language field, and the darkened portion to the so-called language centers:

1. the region in which lesions evoke agraphia (border zone adjacent to the center for the hand);
2. Broca's area, where lesions cause motor a[phasia] (alongside the centers for the vocal and laryngeal musculature);
3. Wernicke's area, where lesions produce word-deafness (alongside the terminal field of the acusticus or at least a part thereof);
4. the region where lesions cause alexia (immediately alongside the cortical center for vision).

A large part of the *central language field* lies in the depths of the Sylvian fissure.

Comment:

This is Freud's only *clinical* neurological (or *neuropathological*) drawing. It identifies the four areas of the brain in which damage produces major language disorders. These anatomical areas can be mapped onto the functional zones and elements that Freud had identified in Figs. 8 and 9 (Plate 30). The distinction between those (functional) images and this (anatomical) one coincides with an important theoretical distinction that Freud drew in his neuropsychological studies from this period: lesions can be *localized* anatomically but functions cannot. This was the fundamental premise upon which he eventually shifted from clinical neurological to purely psychological ground. Psychical locality is a functional locality (see Plate 38). Moreover, the functional localities associated with *neurotic* disorders, unlike neurocognitive ones, cannot be mapped onto anatomical areas on the basis of lesion studies. It is definitional of neuroses that they are not caused by structural brain lesions. Neuroses are functional disorders of the nervous system. But they exist, and they are disorders of the *nervous* system nonetheless. Therefore Freud had to grapple with them, like it or not.



32.

32. *Entwurf einer Psychologie* (Project for a Scientific Psychology), manuscript of 1895. Sigmund Freud Collection, Library of Congress.

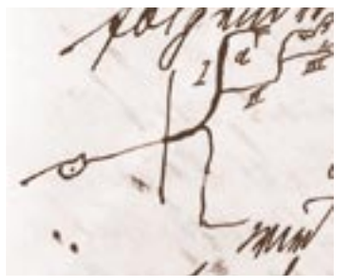
Extract from Freud's text:

"*Quantity* in phi is expressed by *complexity* in psi."

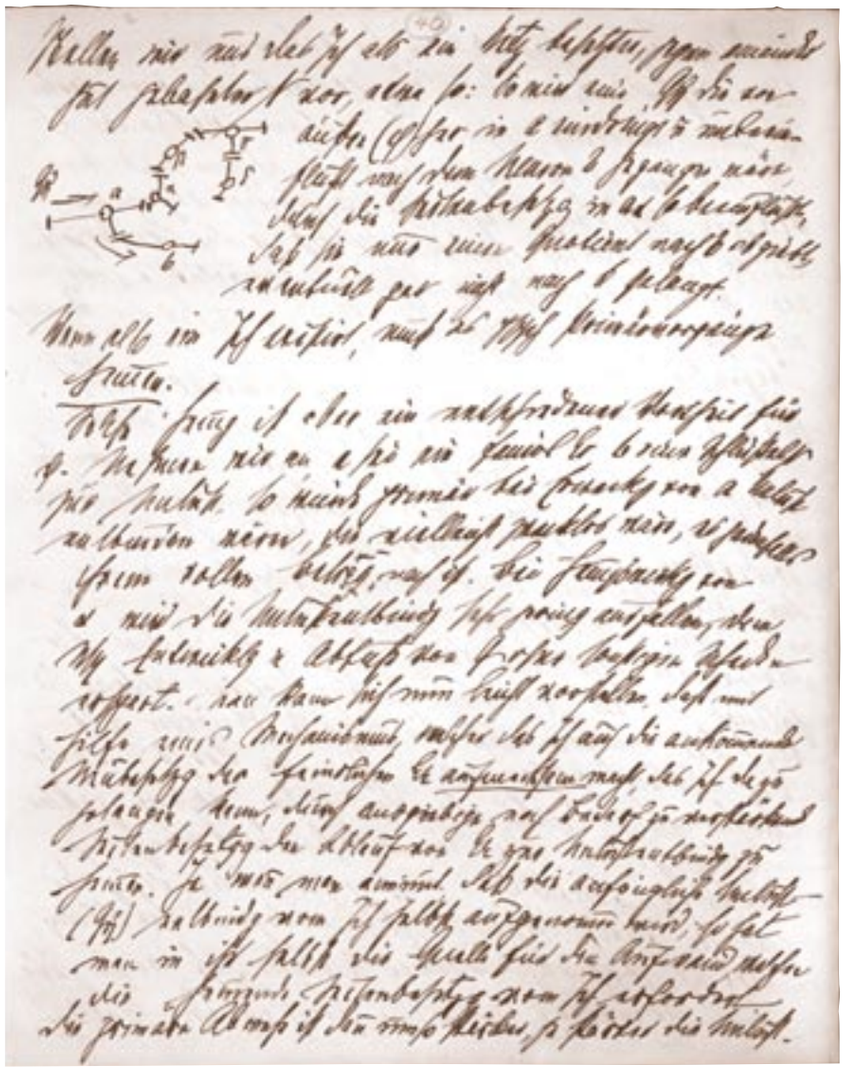
Comment:

The "Project" and the Fliess correspondence contained Freud's final attempts to conceptualize the functions of the mind in neurological terms. The neurological mechanisms which he inferred from his clinical studies of neurotic patients were, however, almost entirely conjectural. This is because the complex mental processes involved could not be mapped onto neuroanatomy (due to the absence of lesions) and physiology (due to lack of appropriate methods). The consequent need to theorize on the basis of "imaginings, transpositions and guesses" (*Project for a Scientific Psychology,* 1895) played a pivotal role in Freud's subsequent abandonment of *neuro*psychological images in favor of *meta*psychological ones – that is, purely functional ones (Plates 40-46).

This schematic drawing below, from the text at left, is divided vertically into two sections: the left half, which contains the cell body of a neuron, is part of the phi (perceptual) system of the brain; and the right half, which contains the terminal branches of its axon, is part of the psi (memory) system. The drawing depicts Freud's inference that phi energies are widely distributed in the psi system, thereby protecting it from excessive stimuli. This precursor of his well-known psychological theory to the effect that internal mental processes require a *protective shield against external stimuli* has interesting parallels with his earlier anatomical theory to the effect that representational processes arise out of the indirect nature of the relationship between peripheral and central elements in the nervous system (see Plate 27).



32. Detail.



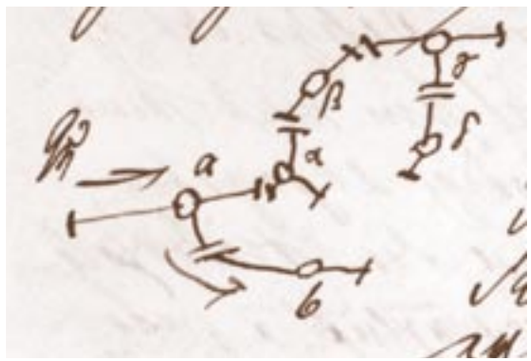
33.

33. *Entwurf einer Psychologie* (Project for a Scientific Psychology), manuscript of 1895. Sigmund Freud Collection, Library of Congress.

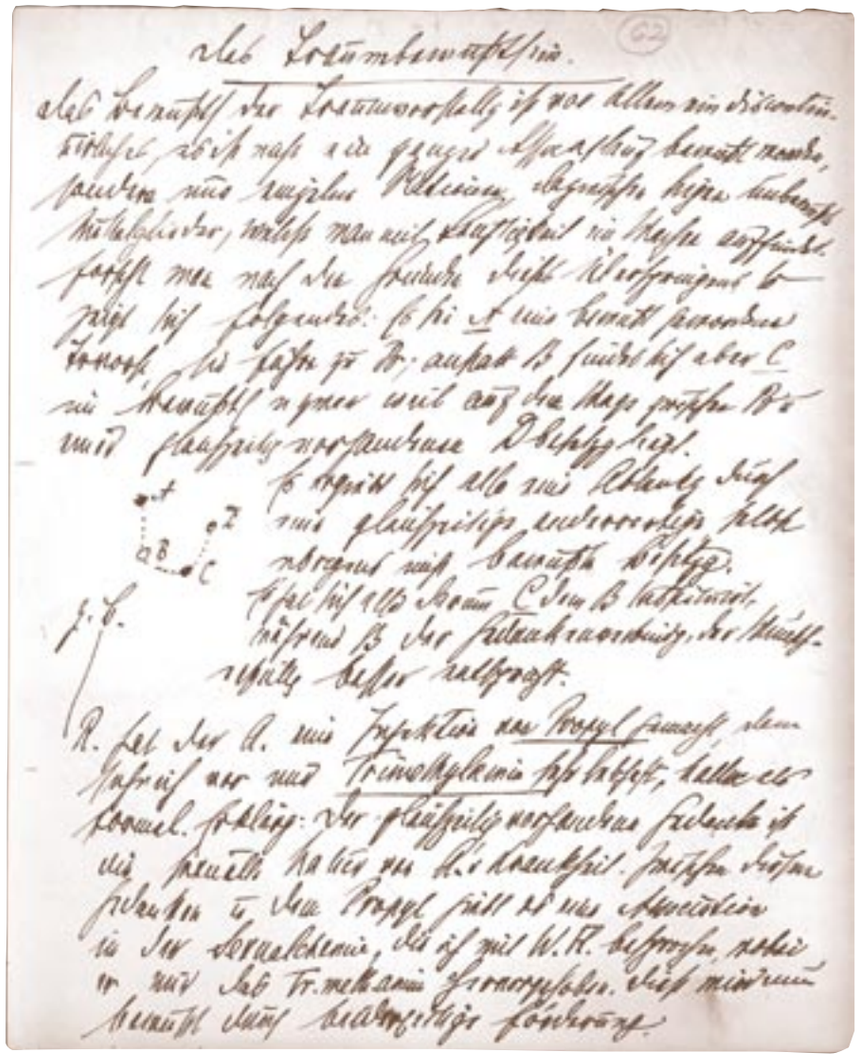
Extract from Freud's text.
"A 'lateral' cathexis thus acts as *an inhibition on the passage of quantity.*"

Comment:

This famous drawing (left and below) depicts another way in which Freud envisaged psi neurons dealing with the threat of excessive stimulation, namely through inhibition. By a mechanism called "side cathexis," Freud imagined that energy could be inhibited by being diverted away from psi (mnemic) neurons which would, if activated, generate feelings of unpleasure (due to their associative connections).



33. Detail.

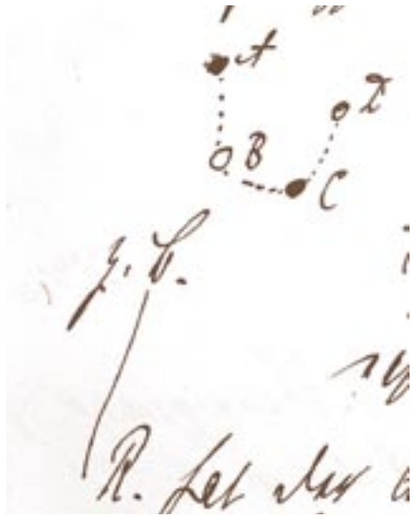


34.

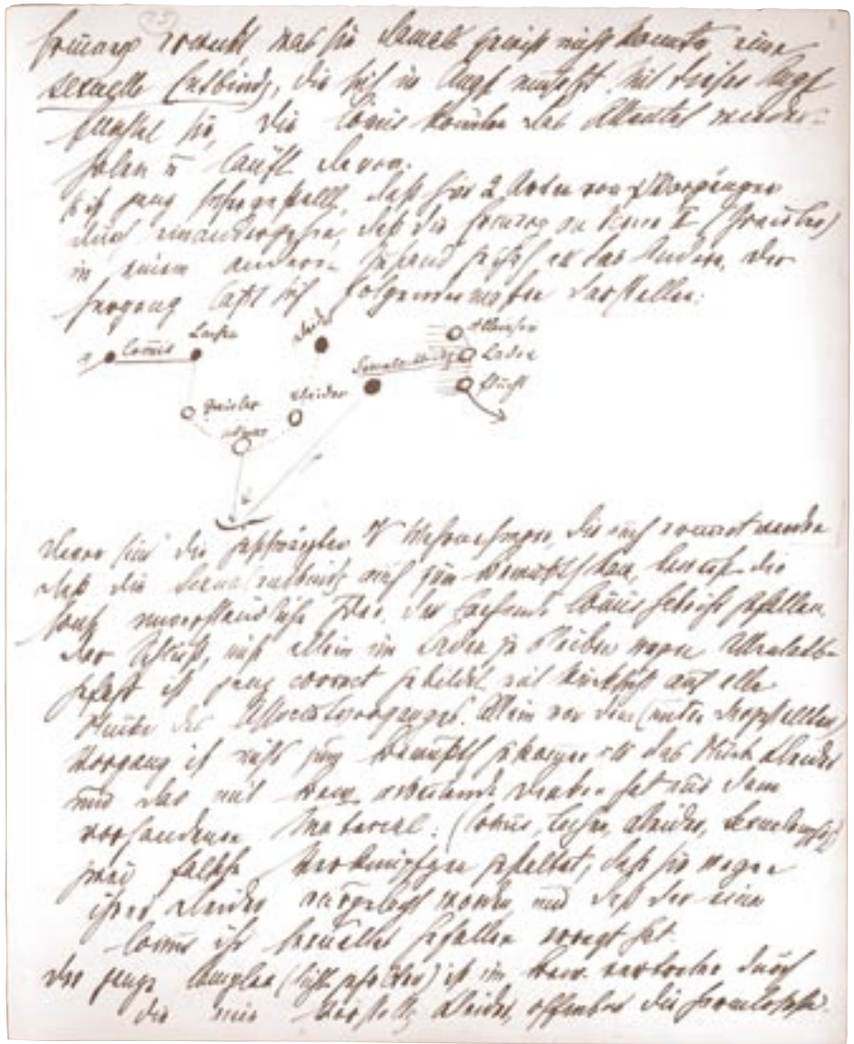
34. *Entwurf einer Psychologie* (Project for a Scientific Psychology), manuscript of 1895. Sigmund Freud Collection, Library of Congress.

Extract from Freud's text:

"Unconscious intermediate links."



34. Detail.



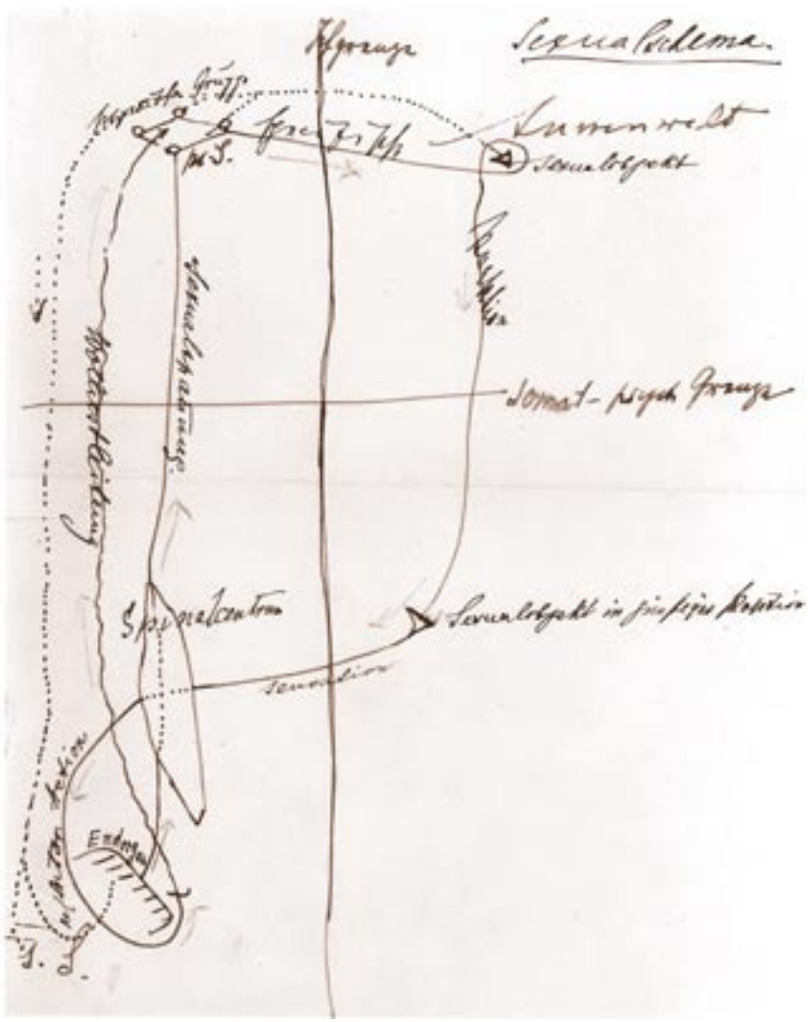
35

35. *Entwurf einer Psychologie* (Project for a Scientific Psychology), manuscript of 1895. Sigmund Freud Collection, Library of Congress.

Comment:

These drawings (Plates 34 and 35) depict a dream and a traumatic memory respectively. The black dots represent associations that generate *conscious* awareness; the white ones are *unconscious* intermediate links. It is noteworthy that anatomical detail is no longer necessary for Freud to portray the functional mechanisms that underpin such complex processes.

35. Detail.

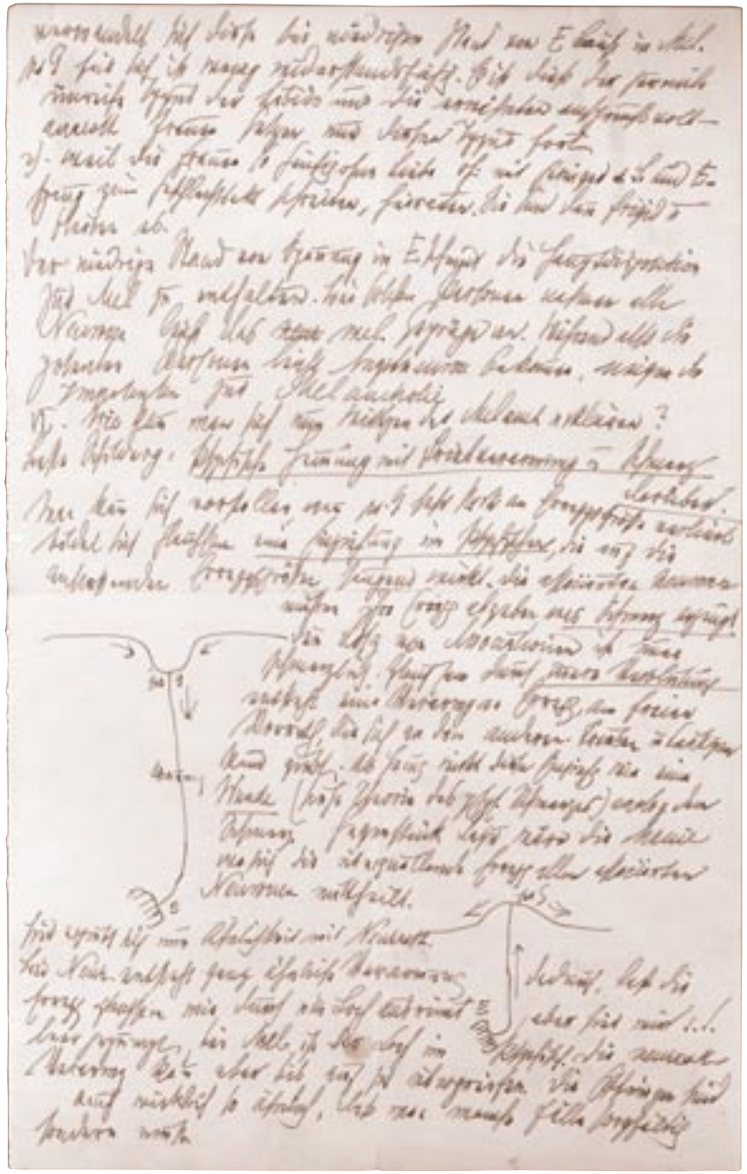


36.

36. Letter to Wilhelm Fleiss, December 17, 1894. Sigmund Freud Collection, Library of Congress.

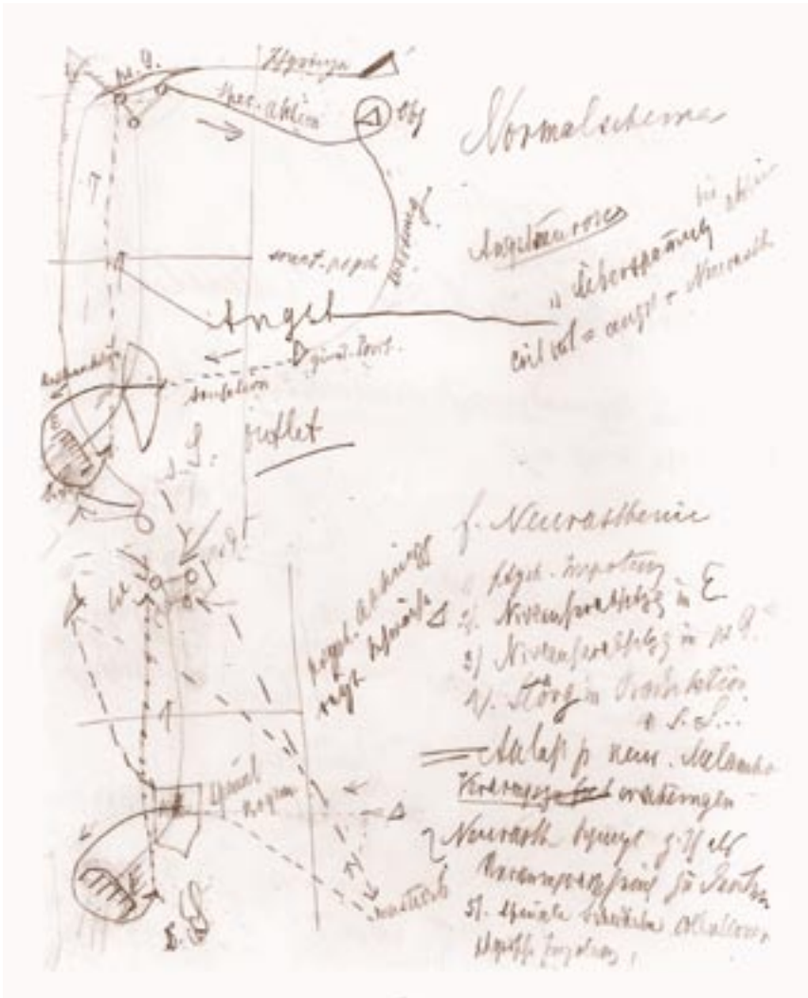
Comment:

The drawing at left and those on the following pages (Plates 37-39) are schematic diagrams of the relationship between various normal and pathological mood states and sexual physiology. These drawings are Freud's penultimate attempts to picture the neurological mechanisms underlying mental processes. The drawings depict theoretical relations he had inferred between sexuality and various mood states.



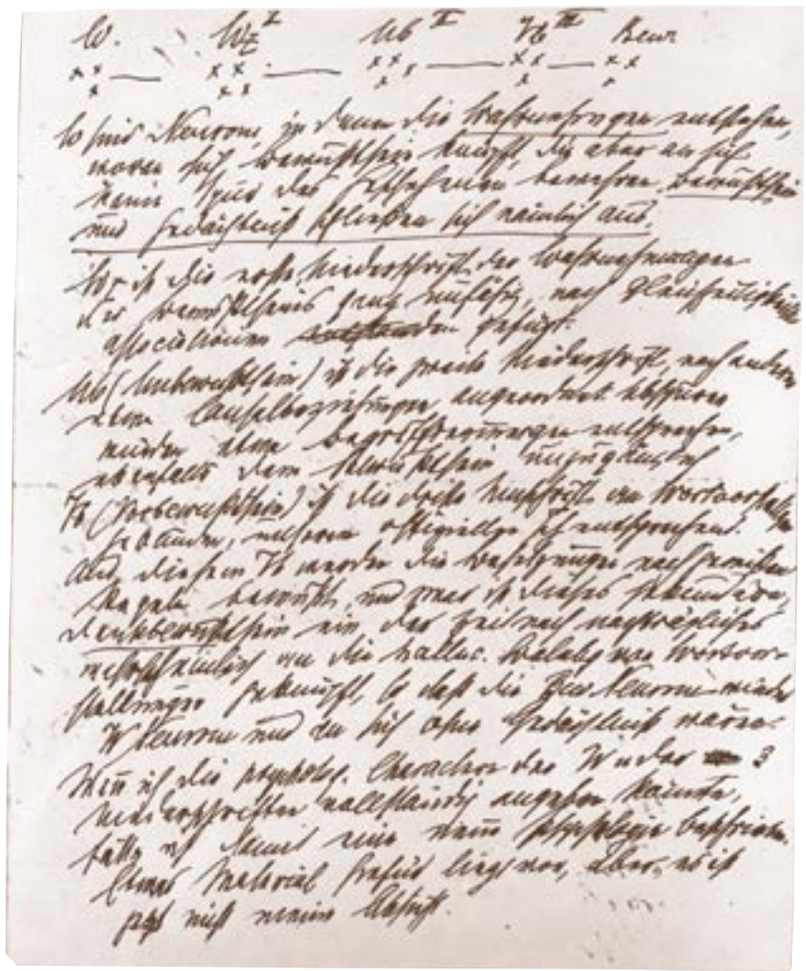
37.

37. Letter to Wilhelm Fleiss, December 17, 1894. Sigmund Freud Collection, Library of Congress.



38.

38. Letter to Wilhelm Fleiss, December 17, 1894. Sigmund Freud Collection, Library of Congress.



39.

39. Letter to Wilhelm Fleiss, December 6, 1896. Sigmund Freud Collection, Library of Congress.

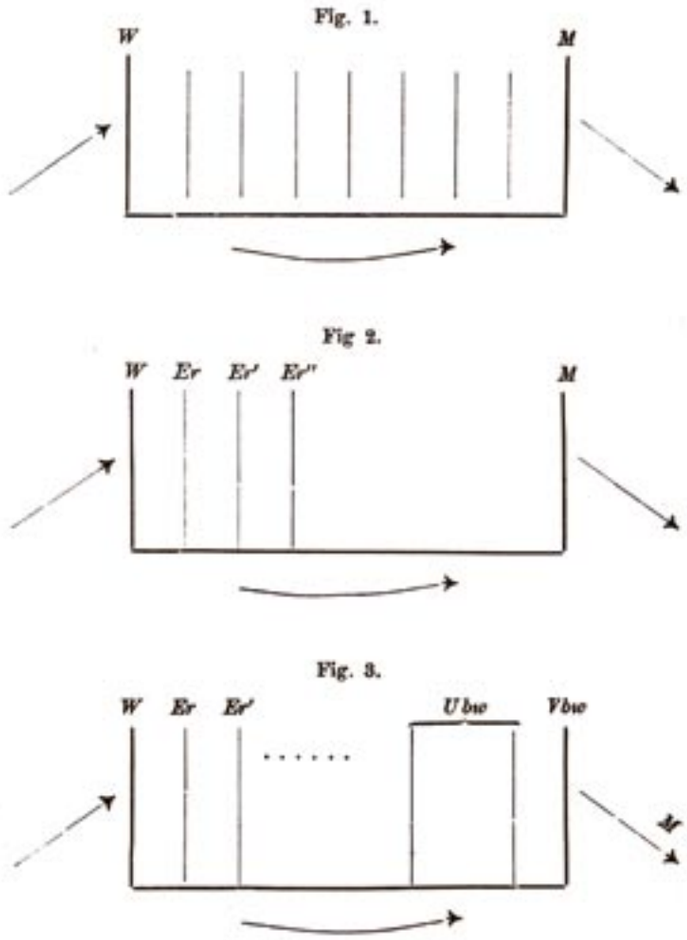
W = Perception.
Wz (I) = Indications of perception.
Ub (II) = Unconscious.
Vb (III) = Preconscious.
Bew = Conscious.

Comment:

This drawing at the top of Plate 39 (a highly schematic depiction of the functional relations between systems of neurons) is Freud's last *neuro*psychological drawing. The diagram directly anticipates the *meta*psychological picture of the same functional relations that he set out four years later in the *Interpretation of Dreams* (1900). The continuity between this diagram and his subsequent metapsychological one (Plates 40) is clearly evident. Its origin in his last theoretical anatomical writings of circa 1886. (Plates 27-29) is also apparent in his letter to Fliess which accompanied the drawing:

"What is essentially new in my theory is the thesis that memory is present not once but several times over, that it is registered in various species of 'signs'. (I postulated a similar kind of rearrangement some time ago, in my study of aphasia, for the paths leading from the periphery.) I cannot say how many of these registrations there may be: at least three and probably more. I have illustrated this in the following schematic picture, which assumes that the different transcriptions are also separated (though not necessarily in topography) in respect to the neurons which are their vehicles. This assumption may not be an essential one, but it is the simplest and is provisionally admissible."

The "not necessarily topographical" separation between the different systems of neurons that Freud refers to is a *temporal* (rather than spatial) one. The drawing therefore depicts a succession of functional connections rather than an anatomical stratification. In the accompanying text, Freud states that *repression* consists in a failure of re-transcription between the Unconscious and the Preconscious-Conscious systems. After this drawing, Freud abandoned all speculation about the physiological substrata of such complex mental processes.



40.

40. *Die Traumdeutung* (The Interpretation of Dreams), (Leipzig und Wien: Franz Deuticke, 1900). Figs. 1-3. Collection of Bruce Sklarew, MD, Chevy Chase, Maryland.

W = Perceptual system.
Er, Er,' Er" = Memory systems.
Ubw = Unconscious system.
Vbw = Preconscious system.
M = Motor system.

Extract from Freud's text:

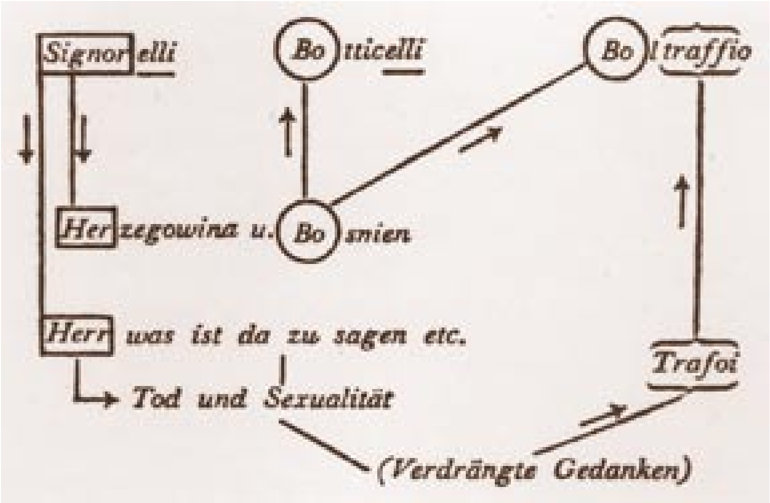
"What is presented to us [here] is the idea of *psychical locality*. I shall entirely disregard the fact that the mental apparatus with which we are here concerned is also known to us in the form of an anatomical preparation, and I shall carefully avoid the temptation to determine psychical locality in any anatomical fashion. I shall remain upon psychological ground, and I propose simply to follow the suggestion that we should picture the instrument which carries out our mental functions as resembling a compound microscope or a photographic apparatus, or something of the kind. On that basis, psychical locality will correspond to a point inside the apparatus at which one of the preliminary stages of an image comes into being. In the microscope and telescope, as we know, these occur in part at ideal points, regions in which no tangible component of the apparatus is situated. I see no necessity to apologize for the imperfections of this or of any similar imagery. Analogies of this kind are only intended to assist us in our attempt to make the complications of mental functioning intelligible by dissecting the function and assigning its different constituents to different component parts of the apparatus. So far as I know, the experiment has not hitherto been made of using this method of dissection in order to investigate the way in which the mental instrument is put together, and I can see no harm in it. We are justified, in my view, in giving free reign to our speculations so long as we retain the coolness of our judgment and do not mistake the scaffolding for the building. And since at our first approach to something unknown all that we need is

the assistance of provisional ideas I shall give preference in the first instance to hypotheses of the crudest and most concrete description.

Accordingly, we will picture the mental apparatus as a compound instrument, to the components of which we will give the name of 'agencies,' or (for the sake of greater clarity) 'systems'. It is to be anticipated, in the next place, that these systems may perhaps stand in a regular spatial relation to one another, in the same kind of way in which the various systems of lenses in a telescope are arranged behind one another. Strictly speaking, there is no need for the hypothesis that the psychical systems are actually arranged in a *spatial* order. It would be sufficient if a fixed order were established by the fact that in a given psychic process the excitation passes through the systems in a particular *temporal* sequence."

Comment:

The difference between the drawing in Plate 39 and Fig. 3 in Plate 40 is minimal; yet the drawing in Plate 40 is famous for being Freud's first diagrammatic representation of the mental apparatus as a *purely psychological* entity. Seen in context with the earlier drawings, it is apparent that the decisive shift in Freud's thinking had actually occurred much earlier, when he moved from describing neurological *structures* to describing neurological *functions*. This applies particularly to higher cortical functions, which Freud saw as involving increasingly *abstracted representations* of more basic bodily processes.

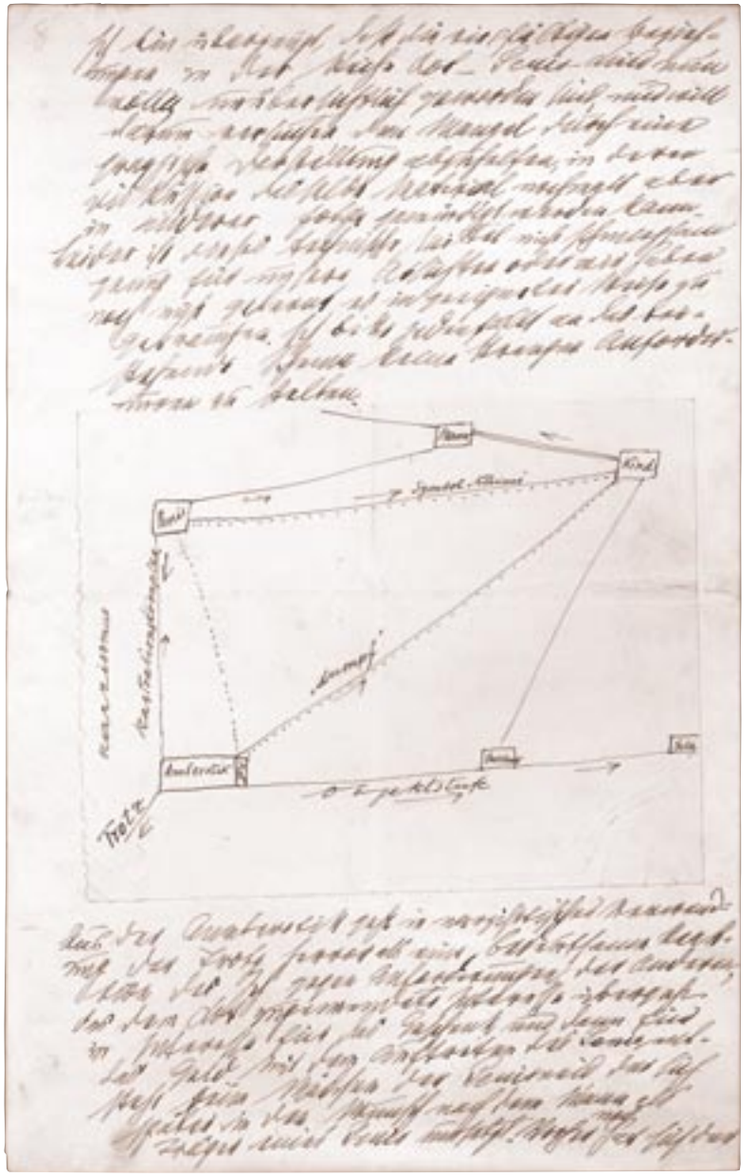


41.

41. *Zum psychischen Mechanismus der Vergesslichkeit* (The Psychical Mechanism of Forgetfulness), *Monatschrift für Psychiatrie und Neurologie*, Bd.4, Nr.6 (Dec. 1898), Fig. 1.

Comment:

This drawing, which depicts associative links between various conscious, preconscious and unconscious word presentations, is conceptually identical with Freud's earlier depictions of neuropsychological processes in dreaming and traumatic amnesia (Plates 34-35).



42.

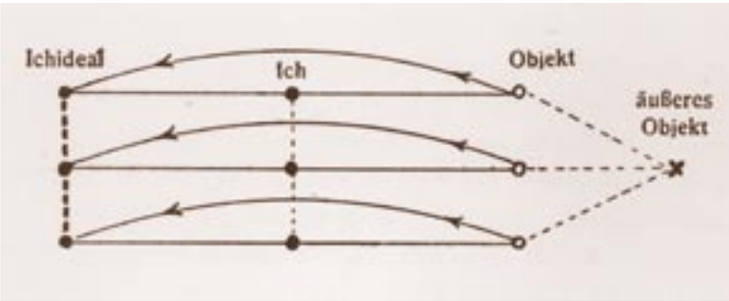
42. *Über Triebumsetzung, insbesondere der Analerotik* (On Transformations of Instinct as Exemplified in Anal Erotism), 1917, Fig. 2. Sigmund Freud Collection, Library of Congress.

Extract from Freud's text:

> "Unfortunately this technical device [diagrammatic representation of manifold mental relations in the case of 'Little Hans'], is not sufficiently pliable for our purpose, or possibly we have not yet learned to use it with effect. In any case I hope the reader will not expect too much from it."

Comment:

The "technical device" to which Freud refers here is *diagrammatic representation* itself. It is clear from this statement why drawings became increasingly rare in Freud's writings as he made the transition from neuroanatomy to psychoanalysis; the processes he was concerned with became progressively more complex, dynamic and abstract, and therefore less amenable to visual modes of representation.



43.

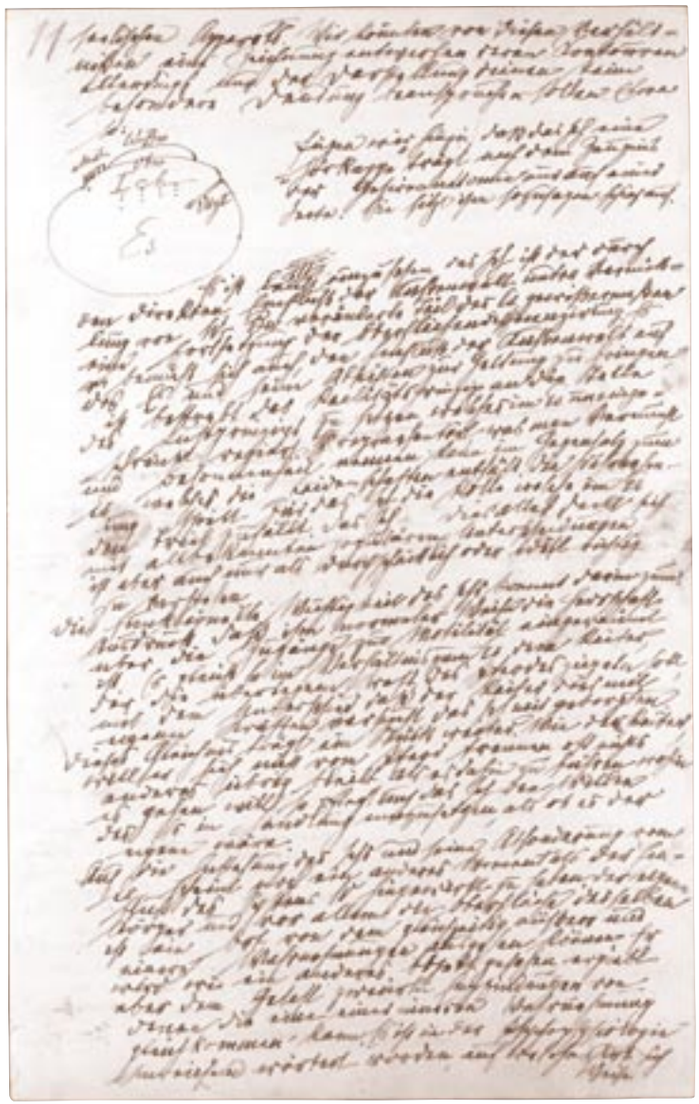
43. *Massenpsychologie und Ich-Analyse* (Group Psychology and the Analysis of the Ego), 1921. Sigmund Freud Collection, Library of Congress.

Extract from Freud's text:

> "*A primary group … is a number of individuals who have put one and the same object in the place of their ego ideal and have consequently identified themselves with one another in their ego.* This condition admits of graphic representation."

Comment:

This diagram is unique among Freud's drawings in so far as it attempts to represent relations between the major mental systems (or agencies) in a group of human minds.

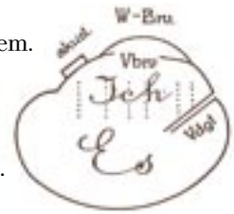


Freud's original drawing (in the manuscript above) for the published diagram (on the opposite page). Sigmund Freud Collection, Library of Congress.

44. *Das Ich und das Es.* (The Ego and the Id) (Leipzig, Vienna, Zürich: Internationaler Psychoanalytischer Verlag, 1923). The New York Academy of Medicine.

Extract from Freud's text:

> "If we make an effort to represent this pictorially, we may add that the ego does not completely envelop the id, but only does so to the extent that the system *Pcpt.* forms its surface, more or less as the germinal disc rests upon the ovum. The ego [Ich} is not sharply separated from the id [Es]; its lower portion merges into it. But the repressed merges into the id as well, and is merely a part of it … The state of things which we have been describing can be represented diagrammatically; though it must be remarked that the form chosen has no pretensions to any special applicability, but is merely intended to serve for purposes of exposition."
>
> *W-Bw* = Perception-Consciousness system.
> *Vbw* = Preconscious system.
> *Vdgt* = the Repressed.
> *Akust.* = nervus acusticus.

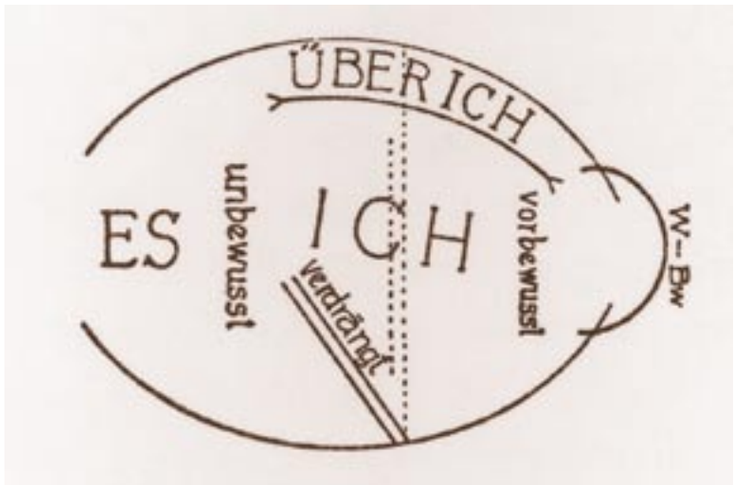


44.

Comment:

The distance Freud had traveled from his earliest anatomical drawings, the whole purpose of which was to picture as accurately as possibly the true physical features of structures laboriously visualized under a microscope, is vividly conveyed by the closing sentence of the extract above. Here, Freud insists that the form chosen is entirely arbitrary, wholly in the service of a verbal description of functional relations between the systems or agencies of the mind.

On the other hand, the long shadow of Freud's neuroscientific training is still evident in the following sentence, which immediately follows the passage quoted above: "We might add, perhaps, that the ego wears a 'cap of hearing' – on the one side only, as we learn from cerebral anatomy." Compare the comment on Plate 30, concerning the special functional role Freud always assigned to language. We should not forget the fact that it was Freud himself who traced the anatomical origin of the nervus acusticus depicted here (Plates 24-26).



45.

45. The psychical apparatus, *Neue Folge der Vorlesungen zur Einführung in die Psychoanalyse.* (New Introductory Lectures on Psychoanalysis) (Leipzig, Wien, Zürich: Internationaler Psychoanalytischer Verlag G.M.B.H., 1933).

Extract from Freud's text:

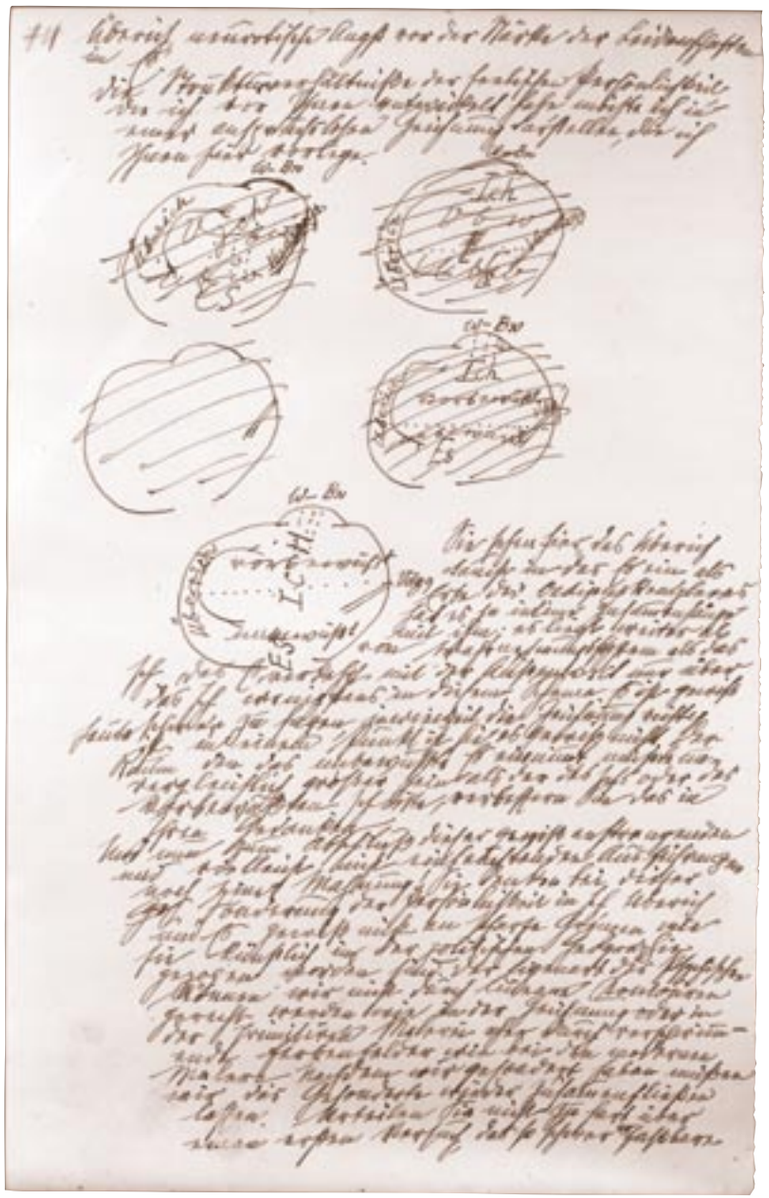
> "I should like to portray the structural relations of the mental personality, as I have described it to you, in the unassuming sketch which I now present you with: [Plate 45]. As you see here, the superego merges into the id; indeed as heir to the Oedipus complex it has intimate relations with the id; it is more remote than the ego from the perceptual system. The id has intercourse with the external world only through the ego – at least, according to the diagram. It is certainly hard to say today how far the drawing is correct. In one respect it is undoubtedly not. The space occupied by the unconscious id ought to have been incomparably greater than that of the ego or the preconscious. I must ask you to correct this in your thoughts."

Comment:

If this diagram is compared with the very similar one in *The Ego and the Id* (Plate 44) it will be seen that the earlier diagram differs from the present one principally in the fact that the *superego* is not indicated in it. Its absence is justified in the following passage from the earlier work: "It would be vain to attempt to localize the ego ideal, even in the sense in which we have localized the ego, or to work it into any of the analogies with the help of which we have tried to picture the relation between the ego and the id." The "sense in which we have localized the ego" to which Freud refers here probably refers to the following passage in the earlier work:

"The ego is first and foremost a bodily ego; it is not merely a surface entity, but is itself the projection of a surface. If we wish to find an anatomical analogy for it we may best identify it with the 'cortical homunculus' of the anatomists, which stands on its head in the cortex, sticks up its heels, faces backwards and, as we know, has its speech area on the left-hand side."

Once again, therefore, the shadow of Freud's neuroscientific training is evident, notwithstanding all his disclaimers. In fact, the implications of the fact that the ego derives from "a mental projection of the surface of the body" cannot be overestimated; for this is merely a restatement in different words of the fundamental insight Freud had first reached in his *Introduction to Neuropathology* (Plates 26-28) to the effect that higher cortical networks transform information derived from the body periphery until it is so altered that it can no longer be reasonably described in anatomical terms. *This transformation is the origin of the mind.* The ego, too, therefore, could ultimately be said to "contain the body periphery in the same way as a poem contains the alphabet, in a complete rearrangement, serving different purposes" (*On Aphasia*, 1891). It is for this reason that the mature ego cannot be "localized" any more than the superego can – and this is also the ultimate reason why Freud had to abandon anatomical drawing for his later "unassuming sketches" of the complexities of the mind.



46.

46. Manuscript for *Neue Folge der Vorlesungen zur Einführung in die Psychoanalyse.* (New Introductory Lectures on Psychoanalysis), 1933. Sigmund Freud Collection, Library of Congress.

Comment:

These remarkable sketches, discovered among Freud's papers in the Library of Congress by Ilse Grubrich-Simitis, show five variants of the diagram that appeared in his "Dissection of the Psychical Personality" in the *New Introductory Lectures* (Plate 43). The variants differ primarily with respect to the relation between the ego and the *Pcs.* on the one hand, and the repressed on the other. Interestingly, the dotted lines descending from the system *Cs.-Pcpt.* into the ego do not appear in the published version. Also, it is evident that the printed drawing has been rotated through 90 degrees. It is unclear whether this change was made by Freud or the publisher.

Contributors

Lynn Gamwell is a historian of art and science and director of the Binghamton University Art Museum of the State University of New York. Her publications include *Sigmund Freud and Art: His Personal Collection of Antiquities* (1989), *Madness in America: Cultural and Medical Perceptions of Mental Illness before 1914* (1994), *Dreams 1900-2000: Science, Art, and the Unconscious Mind* (2000) and *Exploring the Invisible: Art, Science, and the Spiritual* (2002).

Mark Solms is a psychoanalyst and a lecturer in neurosurgery at the St. Bartholomew's and Royal London School of Medicine; chair of neuropsychology, University of Cape Town, South Africa and director of the Arnold Pfeffer Center for Neuro-Psychoanalysis at the New York Psychoanalytic Institute. His publications include *A Moment of Transition: Two Neuroscientific Articles by Sigmund Freud* (1990), *The Neuropsychology of Dreams: A Clinico-Anatomical Study* (1997), *Clinical Studies of Neuropsycho-analysis: An Introduction to Depth Neuropsychology* (2000) and *The Brain and the Inner World: An Introduction to the Neuroscience of Subjective Experience* (2002).

Photo Credits

Library of Congress, Washington, D.C.
Plates #: 1, 2, 27, 28, 29, 32, 33, 34, 35, 36, 37, 38, 39, 42, 43, 44, 46.

Freud Museum, London.
Plates #: frontispiece, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15, 16, 17, 18, 19.

The New York Academy of Medicine.
Plates #: 22, 23.

Chris Focht.
Plates #: 3, 14, 20, 21, 24, 25, 26, 30, 31, 40, 41, 45.

Acknowledgements

It has been a privilege to work with Mark Solms on this exhibition, from concept to opening night. The project was realized through the efforts of many people, to whom I am grateful: Miriam Mandelbaum, curator of books and manuscripts at the New York Academy of Medicine, for the loan of Freud publications and her help presenting the exhibition at her institution; Bruce Sklarew, MD, for the loan of first-edition books by Freud, Sigmund Freud Collection, Manuscript Division, Library of Congress, Washington D.C.; Michael Molnar, acting director, Freud Museum, London; Matthew von Unwerth, director, Abraham A. Brill Library of the New York Psychoanalytic Society & Institute; Tom Roberts, Paterson Marsh Ltd., London, for assistance in obtaining photographs; Susan and Stanley Reifer, for their support of the publication; and Dottie Jeffries, director of public affairs for the American Psychoanalytic Association. As Art Museum director, I organized this exhibition at Binghamton University under the leadership of President Lois B. DeFleur, who inspires her staff to reach for the stars; there, Silvia Vassileva-Ivanova acted as Art Museum registrar and David Skyrca designed this book.

I reserve for last the expression of my profoundest gratitude to the psychoanalyst who has taught me most about the workings of the mind, Peter A. Gelker, MD, PhD.

Lynn Gamwell, Curator of the Exhibition

BINGHAMTON UNIVERSITY
STATE UNIVERSITY OF NEW YORK

UCM 4.06