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Semicentennial Tribute to the Ingenious Neurobiologist Christfried Jakob (1866–1956)

2. Publications from the Second Argentina Period, 1913–1949

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Key Words
Christfried Jakob · Evolutionary neuroscience · Cognitive neuropsychology · Neurophilosophy · Triune brain · History of anatomic neuropathology

Abstract
Christofredo (also Christfried or Christian) Jakob is considered the father of neurology, neurobiology and forensic histopathology in Argentina, where he initially worked between 1899–1910 and then from 1913 onwards. He held professorships of neurobiology at the Faculty of Humanities and Educational Sciences of the University of La Plata and of anatomy and biology at the University of Buenos Aires, and established one of the most important neuropathological laboratories in South America. In the latter phase of his career, Jakob published important works on the pathological anatomy of neurological and neuropsychiatric disorders and formalized ideas on consciousness and neurophilosophy.

Introduction

In the preceding article [1], we covered the activity of Christfried Jakob during his German years and the 'first Argentina period' of 1899–1910. In 1912, Jakob left Germany once again, to return to Argentina permanently. In 1913, he was appointed Chief of the Neuropathological Institute at the Hospicio Nacional de Alienadas, the mental asylum for women in the Federal Capital, and Professor and Director of the Institute of Biology at the Faculty of Philosophy and Letters of the University of Buenos Aires [2].

In 1919, during the period of university reform begun in Argentina after World War I, Jakob was named Professor and Chairman of Descriptive Anatomy at the University of Buenos Aires Faculty of Medicine. He suggested the introduction of histology and embryology in forensic medicine. Apparently, these ideas were not received well by either students or faculty and the new administration forced him (perhaps for other unfathomable reasons as well) to resign the chair. He did so graciously, by declaring that 'students did not understand me, neither did professors' [3].

On March 1, 1922, Jakob was named Professor of Neurobiology at the Faculty of Humanities and Educa-

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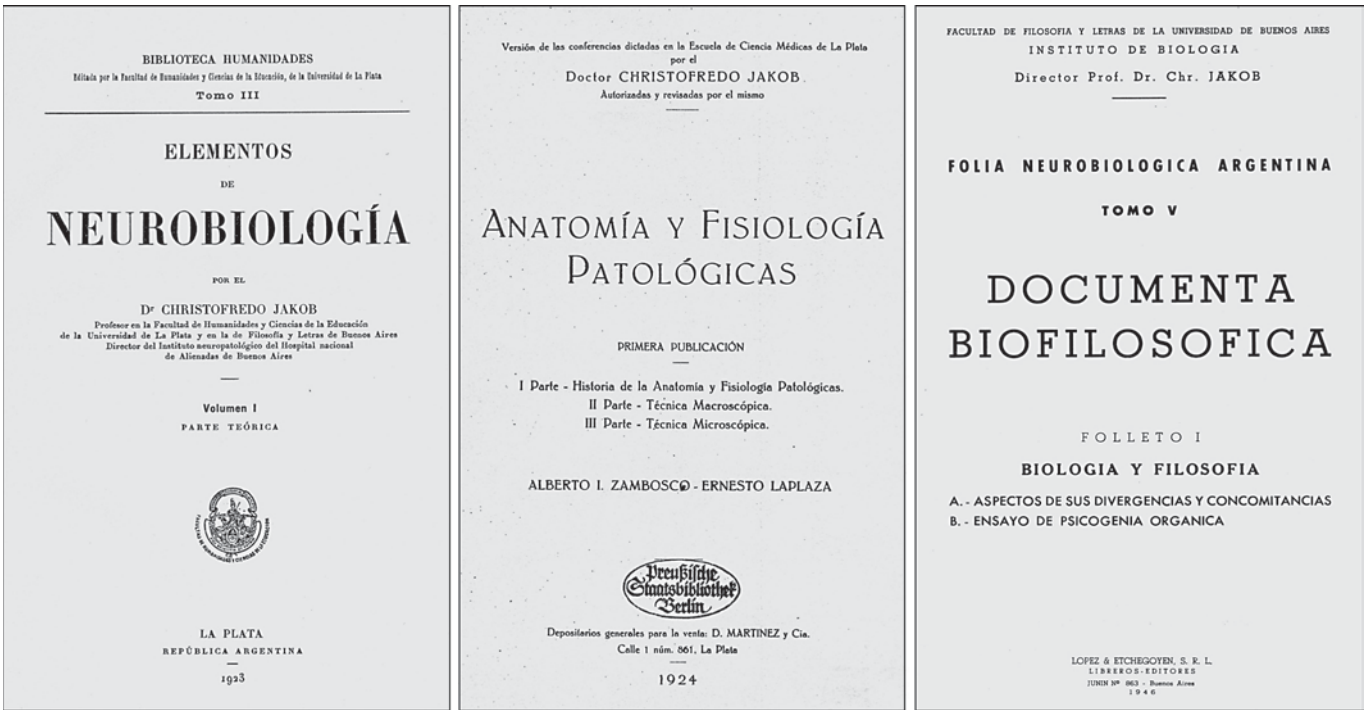

Fig. 1. Three of Jakob's books published in Argentina: left to right, *Elements of Neurobiology* (1923) [8], *Pathological Anatomy and Physiology* (1924) [9] and *Biophilosophical Documents,* being volume 5 of *Folia neurobiológica argentina* (1946) [13].

tional Sciences of the Universidad Nacional de La Plata, by order of the Secretary of Education and University President, Joaquín V. González; from 1921 to 1933, he held a joint appointment as Professor of Pathological Anatomy at the School of Medical Sciences of La Plata [4–6].

Jakob retired in 1945 [5], but kept his formal appointment in Buenos Aires as Chairman of Pathological Anatomy and continued to work in his laboratory at the Hospicio de Alienadas until 1954. He lived in a modest house in Belgrano (a residential neighbourhood in Buenos Aires city). Christofredo Jakob died in Buenos Aires on May 6, 1956. He was close to 90 years of age.

Unfortunately, his work was not always given the recognition it well deserved, even in Argentina. One of us (M.d.C.) recalls the degree to which don Christofredo's life and work were neglected by the majority of the Buenos Aires Medical Faculty of the late 1950s and early 1960s. In those rare occasions when Jakob was remembered, it was as if one referred to a great but remote individual, whose work was of doubtful relevance in the age of cellular and molecular neurobiology.

Newer Monographs

Some 20 monographs were published by Jakob in Spanish during the 'second Argentina period' of 1913–1949. Between 1915 and 1918, he wrote a two-volume treatise on general and special biology [7] for use in schools. The 1923 *Elements of Neurobiology* [8] (fig. 1) is a treatise on the nervous system that begins with an introduction to the triptych 'Cosmos – Life – Mind', continues with the history and methods of neurobiology, then moves on to developmental and comparative neurobiology (fig. 2), nervous histophysiology, organizational principles and principles of conduction, neural and psychic dynamics, and concludes with a chapter on neuropathology and psychopathology. In the preface, written in January 1923 on board the steamship *Cap Polonio* en route to the Tierra del Fuego, one finds Jakob's favourite quote, 'sun and brain are the creators of our worlds'. *Pathological Anatomy and Physiology* (in two volumes) [9] is based on lectures given during 1922 and 1923 at the School of Medical Sciences of La Plata (fig. 1) and covers the history of pathological anatomy and physiology, mac-

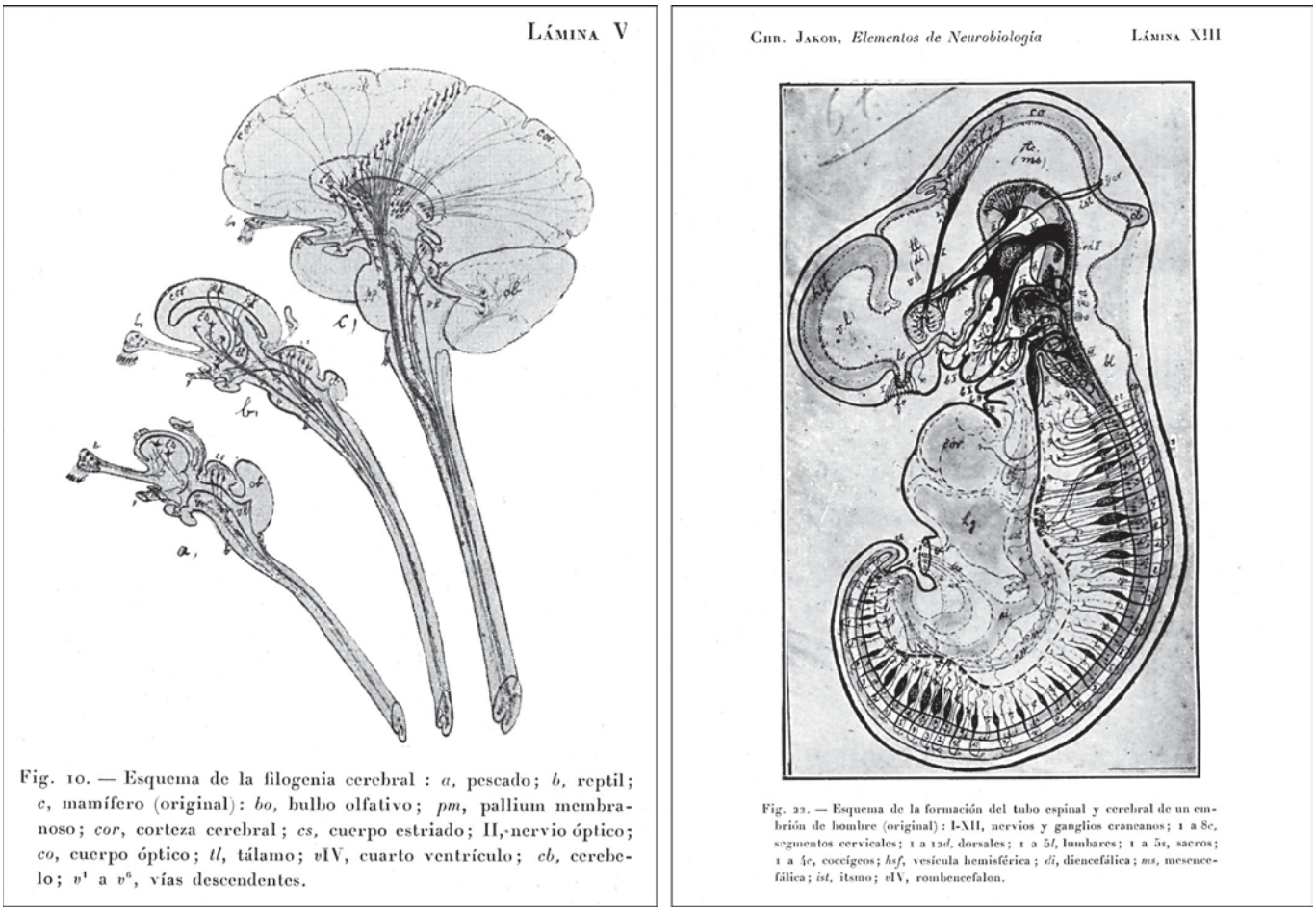

Fig. 2. Original drawings by Jakob, depicting cerebral phylogeny in the fish, reptilian and mammalian nervous system (left) and cerebrospinal ontogeny in a human embryo (right), from his book *Elements of Neurobiology* [8].

roscopical and microscopical techniques, and general pathophysiology.

Three volumes of class notes published by the Faculty of Humanities and Educational Sciences of the University of La Plata include 'Archiencephalon' (1932), 'Paleoencephalon' (1936) and 'Neoencephalon' (1937). Two additional seminar series and lecture notes were published in 1938, the 'Plan of the fundamental organization of the central nervous system of vertebrates' and 'The subcortical organization of the central nervous system of higher vertebrates: the paleoencephalon and its instinctive functions'. Some earlier lectures given at the Hospicio de las Mercedes and in the clinic of Dr. Ramos Mejía in Buenos Aires had been published in 1900 [10] and 1909 [11], respectively.

The *Folia neurobiológica argentina* comprise three richly illustrated atlas volumes [12] and five text volumes [13]. The atlas volumes cover the systematic and topographical anatomy of the human brain, its pathological anatomy in relation to the clinic, and its ontogeny and phylogeny; they total 1,200 pages, including over 1,000 figures plus 650 macrophotographic plates.

Atlas I is literally an atlas of anatomical tomography, a forerunner to modern computed tomography atlases of the head and neck, containing photographs in the coronal, horizontal and sagittal planes. Using a special technique, Jakob prepared his specimens with the brain in situ inside the skull (topographic), either opening windows of varying sizes or cutting the head in whole sections. Atlas II is an atlas of anatomical neuropathology


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Fig. 3. Inaugural issue of the *Review of the Buenos Aires Zoological Garden,* where Christofredo Jakob published 15 articles between 1909 and 1921. Courtesy: Library of Congress.

with clinical correlations. Atlas III has three parts, on comparative neurobiology, systematic phylogeny and cerebral ontogeny, illustrated with specimens from 120 different animal species. Jakob concludes each of the three volumes with a summary on the historical course of cerebral anatomy, anatomic pathology, and phylo-ontogeny.

The five text volumes of the *Folia neurobiológica argentina* [13] cover in their 600 pages general neurobiology, the neurobiology of the edentate *pichiciego pampeano,* the pink fairy of the armadillo species also known as *ratoncito cascarudo* (*Chlamyphorus truncatus*, endangered from 1970), the reptilian *yacaré overo* or 'broad-snouted caiman' *(Caiman latirostris),* anatomo-clinical correlates of the frontal lobe, and issues in biological philosophy (fig. 1).

In the 1940s, Jakob et al. [14] produced three volumes on the human embryo, covering age determination and chronological development, problems of human embryology, gametogenesis, zygote formation, segmentation and gastrulation, and properties of the embryoblast.

Further Neuro-Anatomical and Neuropathological Studies

About two thirds of Jakob's 200 articles date from 1913 onwards. Beside works in anatomy, histology, embryology, phylogeny, pathology, philosophy and neuropsychology, there are 9 geography articles and 2 educational articles on teaching biological sciences and neuro-anatomy at schools and university [15, 16].

Jakob published 13 articles in the *Archives of Psychiatry and Criminology,* a journal founded and edited by José Ingenieros between 1902 and 1913 (later renamed to *Review of Criminology, Psychiatry and Legal Medicine*). These articles are [12, 17]: 'The frontal lobes and higher mental functions' (1906), 'The leptomeninges in mental disorders' (1909), 'Anencephalic monsters' (1910), 'Cerebral histology and psychology' (1911), 'Madness in animals' (1913), 'Motor aphasia and its localization' (1913), 'Psychology and its relation to cortical biology' (1913), 'The harmonic development of intelligence and the brain in the child' (1913), 'Organic psychology and its relation to cortical biology (1913), 'Heredity and psychopathology as dramatic factors in the work of Ibsen' (1929), 'Biological aspects of human typology and its application in Argentina' (1933), 'On the organic bases of memory' (1935), and 'Demonstration of lesions in the zone of language' (1936).

Between 1909 and 1921, Jakob published 15 papers in the monthly *Revista del Jardín Zoológico* (fig. 3). These articles include [5, 12]: 'Cerebrocranial autopsy of an elephant' (1910), 'The importance of comparative histoarchitecture for modern psychology' (1910), 'On the differential psychobiology between human and animal intelligence' (1913), 'An autopsied gibbon and chimpanzee' (1914), 'The language of animals' (1914), and 'An interesting teratological case' (1915).

In an extended article on the biological importance of the cerebellar system (1939) [18], Jakob reviewed 100 years of progress beginning with Purkinje's description in 1837 of the homonymous efferent cell, cerebellar phylogeny from fish through primates, cerebellar ontogeny in the human embryo, anatomical connections, and histophysiological correlations. He concluded the study by mentioning that the production of cognitive processes *(gnosiopoiesis)* uses peripheral information directly related to the thalamus and on to the parieto-occipito-temporal cortex; *praxiopoiesis* ('generation of actions') requires cerebellar information, which passes from the cerebellum and red nucleus to the thalamus and frontal cortex. Thus, these circuits become associated with 'gno-

siopraxic' cortical systems to generate what Jakob calls 'ideopoietic dynamics'.

The year he retired, Jakob published an article [19] in which he described 'an unknown microganglion in the hypothalamic commissure' – in two cases doubled – located in the midline at the region of the mammillary bodies and posterior commissural zone, 'a phylogenetic memory in our brain'. The ganglion measured 0.30–0.45 mm in diameter, its cellular crown and neuropil centre with minimal vascularization being reminiscent of familiar ganglia in invertebrates. Jakob traced the embryological origin of the microganglion to the retromammillary sulcus, just rostral to the mammillary recess in the 3-month-old human embryo. That study is worth preserving, first as a piece of historical knowledge, and second, as potentially deserving some further exploration to determine whether anyone else has seen such a structure since Christofredo Jakob's description.

Further, he described the histology of two brains and a spinal cord in a calf born with two heads and a normal body in the Buenos Aires Zoo [20]. He was solicited for a forensic opinion based on histopathology on two historic occasions, a homicide in 1926 and a psychiatric case in 1930 [21].

Until the 1930s and even later, psychiatry in Argentina was articulated around what Nathan Hale calls the 'somatic style' [2], i.e. a view of mental illness pertaining to the body: the origin of psychiatric disorders could be traced to the morphology of the nervous system, and they were treated accordingly. Jakob had been influential in promoting such a notion for psychiatry.

His neuropathological articles include studies on olivopontocerebellar atrophy [22], pituitary tumours [23], intracranial fibro-chondro-osteoma [24], general paresis [25], cerebral arteriosclerosis [26], cortical changes in schizophrenia [27], forms of Schilder [28], Hallervorden-Spatz [29] and Pick [30] diseases, and the histophysiology and histopathology of the cerebello-hypothalamo-striatal and cerebello-hypothalamo-cortical systems in humans and apes, their diencephalic ontogeny and pathology in 162 cases that included chorea, parkinsonism, encephalitis lethargica, Wilson disease, and Luysian hemiballism [31].

Some additional neuropathological studies dealt with extrapyramidal syndromes [32, 33], the microscopical diagnosis of mental alienation [34], hemiplegia, hemiataxia and hemi-anaesthesia of cerebellar origin [35], infantile paralysis (acute poliomyelo-encephalitis) [36], issues in anatomic neuropathology [37], a family with combined mental retardation, visual and hearing impairment and spastic quadriplegia [38], and dolorous spastic paraplegia from compression of the inferior dorsal medulla by a dural psammomatous endothelioma [39].

In 1942, Jakob published a case of myoclonus associated with a primary lesion of the deep cerebellar nuclei and hypertrophic degeneration of the contralateral inferior olive [40], and a case of secondary degeneration of the central tegmental bundle from a lesion of the cerebellar dentate nucleus [41]. He stated that the central tegmental bundle in humans contains both crossed and uncrossed axons from the dentate nuclei, which join pallidal axons in their trajectory through the brainstem. Jakob thus confirmed the cerebello-olivary fibres in the superior cerebellar peduncle, which had originally been described by Cajal, as a component of the central tegmental bundle, in which Jakob had also identified a dorsal and ventral part that 'continue their descending course spinalward to medullary centres' [42].

A distinct form of lower bilateral ('bibasal') cerebellar degeneration combined with dementia was described by Aranovich [43] as 'Jakob type', based on morphological criteria; it was identified in 15 of 31 cases of cerebellar atrophy in women over 50 years old. The lesion results from an abiotrophic process involving loss of Purkinje cells and originating in the fundus of the marginal sulcus and progresses through destruction of neighbouring lamellae and atrophy of subjacent white matter.

Ideas Pertinent to Cognitive Neuroscience and Neurophilosophy

Jakob viewed 'form as stabilized function and function as change of form; in other words, the vital energy of an organism is a single entity that will present itself as form in the latent state and as function in the kinetic state' [13]. He wrote that 'form, structure and function are inseparable, if not identical, and only scholastic science has managed to separate them … only a basis that is fundamentally biological, morphostructural and histophysiological at the same time, unified in an ample ontogenetic and phylogenetic context, can let us address in legitimate ways the serious questions of modern neuro- and psychobiopathology' [12]. Jakob always considered morphology in a functional context and formulated ideas on the integrative function of the brain. The neurobiology of the frontal lobes occupied him for more than four decades [13, 44, 45].

The following quote is relevant to the topical issue of free will in modern cognitive science: 'It is mnemonic

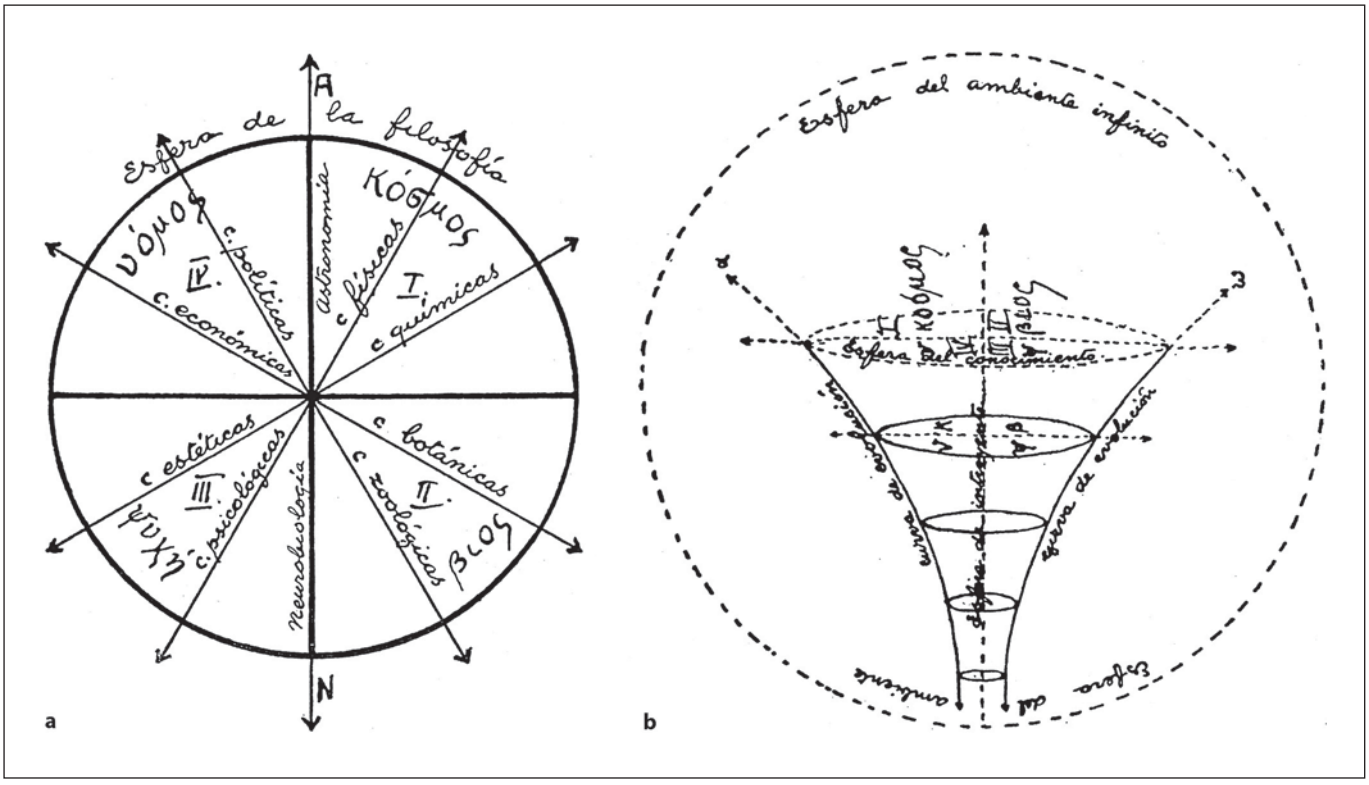

Fig. 4. a Jakob's drawing of the empirical sphere with the four quadrants (I–IV) of the sciences: cosmos (κόσμος), life (βίος), psyche (ψυχή) and order (νόμος). The four quadrants comprise (clockwise from upper-right to upper-left) the physical and chemical (I), botanical and zoological (II), psychobiological and aesthetical (III) and economic and political (IV) sciences. In the two opposite poles (A and N), astronomy and neurobiology invade, respectively, the ultramacrodynamic and the ultramicrodynamic. The sphere of philosophy is marked on the outside of the upper part of the circle. **b** Invasion of the sphere of infinite environment by that of progressive knowledge, delimited by the curve of evolution. From a 1945 article on the philosophical meaning of the human brain [53]. Courtesy: National Library of Medicine.

function that raises the cortical apparatus to its creative potential, its influence and dominant hierarchy in the psyche of the individual, and liberates it from non-salvable ties of reflex law and elaborated instinct; that amplified expectation of action that we call *volitional freedom* consists of the possibility of anticipating the result of a given situation and selecting among various possibilities the one best suited to the momentary constellation and its individual advantage' [6].

The philosophical writings of Jakob include an essay on the philosophy of nature according to Kant [46]; an analysis of heredity and psychopathology as dramatic factors in Ibsen [47]; the psychobiological views of Descartes over three centuries [48]; the significance of Cajal's work for neuropsychiatry [49] and biophilosophy [50] with special emphasis on the cognitive processes of *gnosiopoiesis* and *praxiopoiesis;* a conference on the religion of nature and human future [51], and a presentation of ideas on life and mental experience in relation to time at vegetative, phylogenetic and ontogenetic levels under the encompassing title 'From tropism to the general theory of relativity' [52].

As a basis for the construction of a future philosophy of the brain, i.e. the 'synthesis of neuropsychodynamic theories proven universally valid', useful for a biological psychology and psychiatry, Jakob focused on three concepts: (a) a central organization, (b) heredity and (c) the evocation and transformation of physical processes, through neurohistological, physiological and neurobiological, to psychological phenomena [53]. Considering that the utmost problem of science and philosophy converges in cerebral function, as the most immediate issues

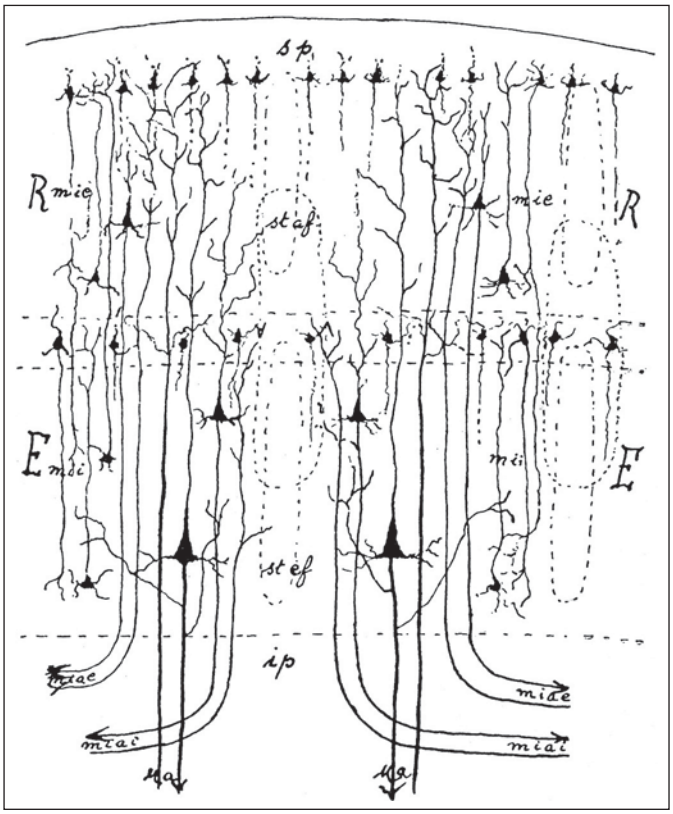

Fig. 5. Jakob's drawing of the microdynamic (mi) organization of the neocortex independently of macrodynamic (ma) events. From Jakob [53]. Courtesy: National Library of Medicine.

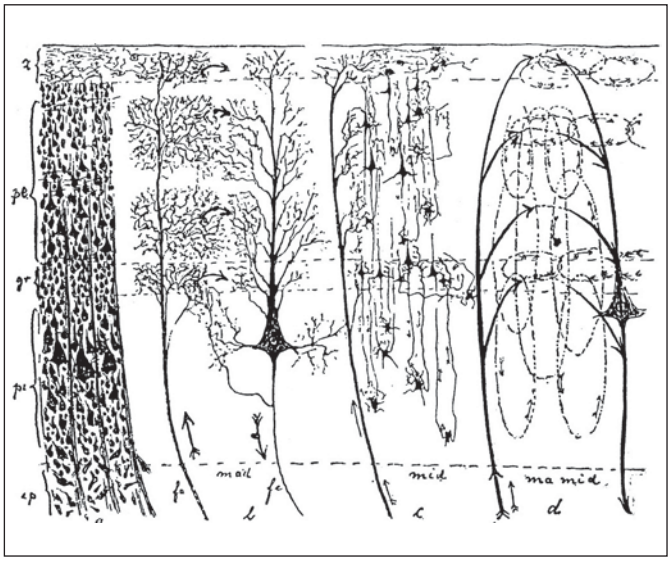

Fig. 6. Neocortical histotopography with its macrodynamic (ma) and microdynamic (mi) events according to Jakob [53, 54]. The scheme depicts the most probable trajectories of nervous current in the cortex: (a) the cortical layers; (b) termination of a thalamocortical fibre and a large motor neuron projecting its axon e.g. to the pes pedunculi; (c) an incoming afferent fibre (fa) in relation to small interconnecting cells, equivalent to the cortical 'microdynamic apparatus'; (d) probable circuits intercalated among afferent and efferent (fe) fibres in the various cortical layers. Z = Zonal (molecular) layer; pe = external pyramidal layer; gr = granule cell layer; pi = internal pyramidal layer. Courtesy: National Library of Medicine.

for the centuries to come he considered: (a) the laws and steps of the quest for cerebral phylogeny and ontogeny; (b) the micro-organization of neuroblasts and the activation of their functional derivatives, normal and pathological, and (c) the poly-energetic cosmo-bio-neuro-psychic transformation in the synthetic transformation of the outer (objective) and inner (subjective) environment (fig. 4). The actual problems in terms of his brain philosophy would then be: neurobiogenesis, neurodynamics and neuropsychogenesis. In his later works [13, 53, 54], Jakob returned to the microdynamic and macrodynamic concepts he had been teaching since the early 1900s, to explain the nature of memory and conscious activity (fig. 5, 6).

One last facet of Jakob's multifarious talent was music. On September 13, 1923, he gave a conference at the National College in La Plata on 'Musical biodynamism' [55], which he illustrated by performing piano works by Wagner and Chopin, as well as works for cello and piano by Grieg and Pergolese, accompanied by Professor Juan Chabra [5]. In 1926, he published an article on 'The spirit of music in pre- and post-Kantian philosophy' [56], in which he reviews fundamental musical elements from the ancient Greeks to the European classical composers and deals with the biology, physiology, psychology, pathology, aesthetics and paedagogy of music.

A 'Triune System of the Psyche' Based on Phylogeny

According to Jakob [12], in the phylogenetic scale, 'psychodynamic' or 'ontopsychic' nervous functions are preceded by 'plasmodynamic' activities, which encompass tropism and pulsatility. The 'neurodynamic' or 'phylopsychic' processes are subserved by three underlying hierarchical levels of the vertebrate central nervous system, designated as archineuronal, paleoneuronal and neoneuronal, and encompass *archikinesias* (reflex ac-

tions similar to invertebrates), *paleokinesias* (instinctual-automated reactions), and *neokinesias* (conscious motor reactions) [8, 57].

In the framework of the dynamic workings of the human cerebral cortex, *neokinesias* include *gnosias* (cognitive processes related to conscious orientation in one's environment), *praxias* (active individual intervention) and *symbolias* (ideative abstraction to facilitate interindividual communication, such as the sociogenetic processes on which human culture is based) [8, 58, 59].

In a certain way, Jakob's proposition on *archipsychic, paleopsychic* and *neopsychic* phenomena in 1923 [8] appears to have anticipated the 1973 'triune brain' concept of Paul MacLean [60] by half a century.

Concluding Remarks

Christofredo Jakob's pursuits spanned beyond neurobiology, neuropathology and comparative neuroanatomy into areas of geography, cognitive science and philosophy, and even cultural issues on Argentina's intellect in relation to the Romanic and Germanic traditions [61].

An inimitable conjunction of broad and firm educational foundations, affluent specimen resources, depth of scholarly focus, the good fortune of longevity and an enduring lucid mind must have conduced to the scientific output of Christofredo Jakob. Some of his contributions may still be useful sources of information for modern researchers in evolutionary and ontogenetic neuroscience, cognitive neuropsychology, and neurophilosophy. In 1939, he stated: 'In the end, in future centuries, we shall perhaps return to a genuine human micro-neuro-psychobiology, and thus *homo sapiens* will be able to aspire to a title which seems more like an irony at the moment, if one considers that we certainly ignore 99 percent of the actual functions of our neuronal elements, and this, despite three centuries of great efforts made by our teachers!' [12].

López Pasquali [62] describes his mentor Jakob as impressive in physical style, corpulent and plethoric, accessible and with humour; a temperament conferring untiring energy and optimism in a multitude and variety of interests; an extreme discipline, methodical character and solid scientific method, facilitating the expedient use of time and task completion. Gregorio Bermann [63] recalls Jakob's extraordinary vitality, until the end of his long life, his animated figure with the precise movements, his vivacious and sharp eyes, his pictorial language, with the foreign and admirable eloquence of the facts that filled his lectures. Besides biomedicine and philosophy, Jakob's diversions included music, poetry, mineralogy and journeys through unexplored territories of Argentina, Chile, Bolivia and Peru. He also taught biology at high schools, as he believed that the governing ideas of thought are generated in adolescence.

Jakob commanded a culture that included the classical Greek and Latin literatures. He begins his thesis with an original quote from Aretaeus of Cappadocia on the vena cava. In one of his later papers, we read: 'The most cultured people that have existed, the Hellenic, had beautified, *honoris causa,* in that art (music) the special name of *art of the Muses* and, symbolically, the great Plato had declared that philosophy is the science and art of truth like music' [56].

Christofredo Jakob's philosophical stance on life is exemplified in a *credo* he imparted for the man of the future [51]: 'I believe in the harmony of the Universe; in the triumph of Life; in the victory of the human spirit; in the mutual responsibility of individuals and nations; in an expanding universal confraternity and in a God of justice and love for all, without discrimination against races or religions, and who will be revealed to us, inside and through us, with the progressive humanization of the future, yet not with talk but with deeds'.

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