

**An Avant-Garde Professorship of Neurobiology in Education:
Christofredo Jakob (1866–1956) and the 1920s Lead of
the National University of La Plata, Argentina**

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Abstract

The interdisciplinary trend in “Mind, Brain, and Education” has witnessed dynamic international growth in recent years. Yet, it remains little known that the National University of La Plata in Argentina probably holds the historical precedent as the world’s first institution of higher education that formally included neurobiology in the curriculum of an educational department, having done so as early as 1922. The responsibility of teaching neurobiology to educators was assigned to Professor Christofredo Jakob (1866–1956). In the present article we highlight Jakob’s emphasis on interdisciplinarity, and in particular on the neuroscientific foundations of education, including special education.

Keywords

Christfried Jakob, cerebral onto-phylogeny, history of neuroeducation, neurophilosophy

Introduction

Some of the earliest attempts at applying neurobiological findings to education can be traced to the work of the neurologist Henry Herbert Donaldson (1857–1938) and the educator Reuben Post Halleck (1859–1936) (Théodoridou & Triarhou, 2009). The new tools of biology and cognitive science have generated vast possibilities for this field, enabling the integration of diverse disciplines which study human learning and development (Fischer et al, 2007). Terms used interchangeably to denote this new branch of knowledge include “neuroeducation” (Battro & Cardinali, 1996), “neurolearning” (Petitto & Dunbar, 2004), “nurturing the brain” (Ito, 2004), “developing the brain” (Koizumi, 2004), “mind, brain, and education” (Fisher et al., 2007), “educational neuroscience” (Geake, 2005; Szüks & Goswami, 2007), and “pedagogical neuroscience” (Fawcett & Nicolson, 2007).

The dynamic growth of “neuroeducation” and the opportunities for interdisciplinarity are evidenced by: (a) the establishment of academic programs and departments, such as the “Centre for Neuroscience in Education” at the University of Cambridge, the “Mind, Brain, and Education Program” at the Harvard Graduate School of Education, and Dartmouth’s “Center for Cognitive and Educational Neuroscience”; (b) the emergence of the “International Mind, Brain, and Education Society” and the launch of its official journal in 2007, as well as the launch of another new journal in 2012, the “Trends in Neuroscience and Education”; (c) the organization of congresses, meetings and seminars at both the international [EARLI, Zürich, 2010; International MBE Society, Philadelphia, 2009, San Diego, 2011] and local levels [Collaborative Frameworks for Neuroscience and Education, UK, 2005–2006]; and (d) the attention received in the mainstream press and by the lay public (see also Beauchamp & Beauchamp, 2012).

There are additional examples of the worldwide impact of the neuroeducation movement. In the United Kingdom, the TLRP-ESRC seminar series on Neuroscience and Education brought together national and international education and science experts to discuss how these two areas may collaborate. At its conclusion, in June 2006, over 400 teachers, educational researchers, psychologists and neuroscientists had participated in the series. In Germany, the Federal Ministry of Education and Research found it reasonable to concentrate on the latest line of research in educational neuroscience to improve education (Stern, 2006). In Finland, a national network on neuroscience and education

hosted its activities in the University of Helsinki, beginning in 2009, under the theme “The Brain, Learning and Education Network.”

Still, it remains a little known fact that the National University of La Plata in Argentina holds a historical precedent as most likely the world’s first institution of higher education that formally introduced and included neurobiology in the curriculum of an education department. It was Christfried Jakob (1866–1956) (Figure 1), a Bavarian-born neuropathologist, who promoted the initiative to teach brain structure and function to students of the Faculty of Philosophy and Letters as early as 1922.

Prior to 2006, a literature search in the PubMed database would yield no returns on Jakob, save an article by Meyer in Spanish (Théodoridou, 2011). Since 2005, a systematic effort began by one of us (LCT) and his colleagues to retrieve and revive Jakob’s writings; this ongoing project has aimed at placing Jakob’s ideas in a modern neuroscientific perspective (Théodoridou & Triarhou, 2011, 2012a, 2012b; Triarhou, 2008, 2009, 2010a, 2010b; Triarhou & del Cerro, 2006b, 2006c, 2007; Tsapkini, Vivas, & Triarhou, 2008; Vivas, Tsapkini, & Triarhou, 2007). In the present study we review Jakob’s contributions to education, an endeavor that he pursued throughout his career.

Jakob’s professional life

Jakob [his forename castillianized to “Christofredo”], the founder of neuropathology in Argentina, adopted that country as his home and lived there from 1899 until his death in 1956, with only a brief visit to Europe in 1910 (Fumagalli & Saredo, 2005; Moyano, 1957). He was recognized for his neuroanatomical work, particularly for the systematization of brain sectioning and application of the Weigert method to the study of myelinated fiber tracts (Allegrì, 2008). He authored 30 books and 200 articles on developmental, evolutionary, anatomical and pathological neurobiology (Figure 2) (Triarhou & del Cerro, 2006c). His approach was largely based on studying species of Argentinian fauna (Papini, 1978, 1988). For example, his theory on the phylogenetic origin of the neocortex (Jakob, 1945) issued from his histological studies on *Amphisbaena*, a small apod reptile (Papini, 1988). Jakob is credited with combining phylogenetic, embryological and functional approaches in a quest to explain the role of the cerebral cortex in cognition and behavior (Triarhou, 2008b). From such an attempt ensued his theory of a dual developmental-evolutionary origin and ubiquitous sensory-

motor function of the cerebral cortex (Jakob, 1911, 1912a, 1912b; Triarhou, 2010b). He further studied and highlighted the fields of neurophilosophy, affective neuroscience and educational neuroscience (Théodoridou, 2011; Triarhou, 2008a). He did so based on his collective academic, clinical and research experience from multiple vocational frameworks, including universities (National University of Buenos Aires and National University of La Plata), hospitals (Las Mercedes Hospital in Buenos Aires and National Psychiatric Hospital for Women in the Federal Capital), and research laboratories (Laboratory of the Psychiatric and Neurological Clinic of Las Mercedes Hospital, Neuropathological Institute at the National Psychiatric Hospital for Women in the Federal Capital, and Institute of Biology at the Faculty of Philosophy and Letters of the National University of La Plata) (Triarhou & del Cerro, 2006b, 2007).

His work can be roughly divided into three periods, each having a slightly different focus. Jakob shared the “early period” of his work [1890–1912] between Germany and Argentina, carrying out anatomical studies (Théodoridou & Triarhou, 2012a). During his “middle period” [1913–1935], he developed his psychobiological ideas (Théodoridou & Triarhou, 2011). In the “late period” [1936–1949], he formulated a neurobiophilosophical synthesis (Théodoridou & Triarhou, 2012b).

Overall, Jakob realized the essence of the current definition of the mind, brain, and education convergence, i.e., “the integration of disciplines that investigate human learning and development bringing together education, biology, and cognitive science” (Fischer et al., 2007, p. 1) as his life’s paradigm. In 1899, at 33 years of age, Jakob had already attained renown after publishing a handbook of neuroanatomy and neuropathology that was translated in multiple languages (Triarhou & del Cerro, 2006b). In that year, he accepted an offer by Domingo Cabred (1859–1929), the Argentinian Professor of Psychiatry, to take over the organization of the Laboratory of the Psychiatric and Neurological Clinic of the Hospital of Las Mercedes at the National University of Buenos Aires (Orlando, 1966). The prospect of having 300 brains available for pathological study on an annual basis was a key factor that influenced his decision to leave Germany for South America (López Pasquali, 1965). Thus, he moved to Argentina, having signed a three-year contract.

During that time, he struggled to transform his innovative ideas into action. Already in 1906, encouraged by the visionary Minister of Public Education, Joaquín V. González (1863–1923),¹ Jakob asked for permission from the University of Buenos Aires to introduce a new course under the title “The nervous system and its relationship to education” (Orlando, 1966). However, he met with resistance, and it took several years for such an initiative to be effected. (It is not surprising that even in the recent past, the idea that neuroscience is or should be an important aspect of educating educators often sounded foreign to pedagogues or psychologists, who, not knowing a neuron from a glial cell, had little interest in neurobiology, and avoided any serious study of the brain like the plague. The attitude that neuroscience is irrelevant for educators, other than as a subject matter to be taught by someone else, and the predilection instead for behavioral and psychological theories and practices are fortunately waning.)

The “Universidad Provincial de La Plata” was inaugurated on April 18, 1897 under the Administration of Dr. Guillermo A. Udaondo (1859–1922), Governor of Buenos Aires, with Dr. Dardo Rocha (1838–1921) serving as Rector.² The University of La Plata became nationalized by Act 4609 of Congress and by Provincial Law on September 29, 1905. When González was appointed its President the following year, he integrated several municipal scientific institutions into the University

¹ González was admitted into the *Real Academia Española*, the Royal authority on the Spanish language, in 1906, and was elected to the Argentine Senate in 1916 (while still President of the University). Retiring from the latter in 1918, he returned to the University of Buenos Aires, where he taught Constitutional Law, Public Law, and a course in the History of Foreign Relations of Argentina. He contributed regularly to *La Nación* as a columnist, and translated Rabindranath Tagore’s *One Hundred Poems of Kabir*. He joined the International Law Association in 1919, and advocated on behalf of the League of Nations, as well as U.S. President Woodrow Wilson’s efforts towards its ratification by a recalcitrant Senate. His most controversial work, *Patria y Democracia* (Fatherland and Democracy), was published in 1920, and delved into regional and political tensions in Argentina. González’s efforts on behalf of the League of Nations helped lead to his nomination to the International Court of Justice at The Hague, becoming a member in 1921. González died in Buenos Aires in 1923; he was 60. *Fábulas Nativas*, a work of cultural anthropology, was published posthumously in 1924, and González left a bibliography of over a thousand works, including 50 books on a variety of academic subjects.

² Rocha was an Argentine naval officer, lawyer and politician best known as the founder of the city of La Plata and of the University of La Plata. La Plata was planned by the architect Pedro Benoit in a regular pattern of diagonals and precisely placed squares. His success in La Plata led the Governor to seek his party’s nomination for the Presidency in 1886. Rocha was a well-known, well-connected and persuasive candidate who had secured his place among Argentina’s paramount “Generation of 1880”, but lost the nomination to Miguel Juárez Celman, the Governor of the Province of Córdoba and President Roca’s son-in-law.

and brought substantial change by placing an emphasis on experimental and natural science methods (González, 1905). For example, he introduced modern academic physics to the country (Glick, 1996).

Jakob held faculty positions at the University of Buenos Aires from 1913 to 1944 and at the University of La Plata from 1922 to 1933 (Papini, 1988). In 1912, the Faculty of Philosophy and Letters of the University of Buenos Aires created a Professorship of Biology in an attempt to enhance the scientific status of the School (Nazar Anchorena et al., 1927; Orlando, 1966).³ Jakob was then appointed Professor, and assumed the task of building a solid biological basis for psychological and philosophical studies (Talak, 2008). The reverberation of the success of Ramón y Cajal in the Hispanic world and his Nobel Prize award must have played a part in the emphasis placed by the University of La Plata on the brain sciences. For instance, in 1906, the “Archives of Pedagogy” (official journal of the Faculty of Education) published in the inaugural volume two papers by Cajal on the morphology and connections of nerve cells (Ramón y Cajal, 1906a, 1906b). The inclusion of highly technical neuroanatomical papers in a purely pedagogical journal is in itself a remarkable act. The following year, on December 14, 1907, the Science Museum of the University of La Plata bestowed Cajal the title of “Honorary Academician” (Ramón y Cajal, 1988, p. 628).

In 1913 Jakob published the “Atlas of the Brain of Mammals of Argentina” in collaboration with Clemente Onelli (1864–1924), the director of the Buenos Aires Zoo. Jakob and Onelli (1913) intended to establish the biological basis of mental phenomena, underscoring that psychology would either use the comparative method in studying nervous function and structure, in order to shed light on psychological phenomena, or it would be limited to the descriptive method (Papini, 1988). Eventually, in 1922, the National University of La Plata appointed Jakob as Professor of Neurobiology at the Faculty of Humanities and Educational Sciences (Triarhou & del Cerro, 2006c), rendering him one of the first academic teachers of neurosciences in a department of education (Figures 3 and 4). In fact, his course “Anatomy and Physiology of the Nervous System” (Figure 5) was taught in freshman year to the future teaching workforce of the country (Gotthelf, 1969).

³ Nazar Anchorena. The Anchorenas were one of the most traditional, socially prominent, and richest families of Argentina. There was a saying: “Rich as the Anchorenas.”

Jakob's insight into the evolutionary basis of behavior, founded on his research in comparative developmental neuroanatomy, became known and cited. In one of the early textbooks of biological psychology (translated in French and German and prefaced by Wilhelm Ostwald, Nobel laureate in chemistry), the philosopher-psychiatrist José Ingenieros (1877–1925) credits Jakob and the palaeontologist Florentino Ameghino, along with Ramón y Cajal, van Gehuchten, Golgi, and von Lenhossék, for their fundamental discoveries in the anatomy and phylogeny of the nervous system (Ingenieros, 1922; Triarhou & del Cerro, 2006a). In the postscript to his autobiography, the great Ramón y Cajal (1988, p. 602) acknowledges Jakob (1922) among the foreign scientists of prestige who contributed to the two-volume *Festschrift* on the occasion of his retirement at the age of 70, including the Vogts, Loeb, Herrick, Sherrington, von Monakow, Marie, Houssay, and numerous others. Finally, in their monumental *Cytoarchitectonics*, von Economo and Koskinas (1925) argue that future research on the human cerebral cortex will have to be based on the work of three most important cortical neuroanatomists, i.e. Theodor Kaes, Ramón y Cajal, and Christfried Jakob, whose ideas on cortical phylo-ontogeny they call ingenious.

In the capacity of Professor of Neurobiology in the School of Humanities and Educational Sciences, Jakob epitomized the neuroeducational idea through his teaching and research activities, discussed next.

Teaching neurobiology to educators

In considering the fervent growth of Educational Neuroscience, we note that the attempt to bridge neuroscience with the humanities goes back more than a century. The books of Donaldson (1895) and Halleck (1896) were published at the same time as Jakob's first atlas of the normal and pathological nervous system (1895). We do not have any evidence that Jakob was aware of Halleck's or Donaldson's books. Nevertheless, some years later he laid a new stone in the formation of Educational Neuroscience.

Throughout his career, Jakob defended the dissemination of neuroscientific knowledge into the humanities. He dealt with that topic in his *Documenta Biofilosófica* (Biophilosophical Documents) (Jakob, 1946). He developed his rationale as follows (Théodoridou & Triarhou, 2012a): First of all,

life sciences form a justified basis for an objective, rational and scientific development of philosophical orientations (Jakob, 1946). Thus, the scientific field that studies nervous structure and function is indispensable for psychology and its related sciences. Further, knowledge of the evolution of the human brain in correlation with cognitive development, as well as brain alterations and their sequelae on memory, behavior, language and other abstract processes, form the natural foundation of a conscious learning science, as the creation and preservation of higher cognitive functions (intellect, volition and emotions), instincts and reflexes depend on human cerebral organization. Thus, Jakob called for a learning science aware of the biological mechanisms that underpin learning.

In a commentary on “The function of biology in a faculty of philosophy and letters,” Jakob (1942) argued that future teachers and professors, aware of their highest mission, ought to know the fundamental facts of brain development as well as the physiological capacity of its mentality and disorders, because development and its dynamics form the anatomical-physiological substrate of their instructional efforts.

Jakob presented these ideas in a monograph on the frontal lobe, which he characterized “rather as a plan for future research and not as an essay with solutions” (Jakob, 1943b, p. 9). Recognizing the “humanizing” role of the frontal lobe, he described the meaning of its dynamics for science and philosophy (Théodoridou & Triarhou, 2012b).

The fact that the human frontal cortex covers about 30% of the total cortical surface generated the hope that unravelling its function might eventually explain human behavior (Raichle, 2002). Jakob (1906) viewed the major part of the frontal lobe as a central station with multiplier and combinatorial characteristics, constantly receiving stimuli from all the motility organs via multiple pathways. The role of the frontal lobe in integrating information from multiple brain areas supports its crucial involvement in learning, comprehension, and reasoning (Baddeley, 2002). According to Fuster (2006), actions related to human behavior, reasoning, and language are organized by means of interactions between prefrontal and posterior networks at the top of the “perception-action cycle.” Jakob placed in the frontal lobe the centers of experiential accumulation that results from personal intervention, elaborated progressively for elemental and higher human skills and stimulated by affective states.

In particular, Jakob explained the relation of the frontal lobe to education as follows: “The

development of a social intelligence that will reinforce individual inclinations and will put emphasis on the active engagement of the student in the formation of concrete knowledge issues from the importance of frontal lobe functions” (Jakob, 1943b, p. 140).

As a result of the progress in the brain sciences in recent decades, traditional philosophical questions have been steered in new directions (Churchland, 2008), inviting a broad and divergent body of scientists to work together. Following philosophy, education has been enriched with new information stemming from the neurosciences.

For example, imaging studies pinpoint to neural systems that are responsible for the acquisition of reading skills, and further support the idea that we can remedy inefficiencies in those systems through intervention; behavioral outcomes are accompanied by neural changes in the expected areas (Goswami, 2006). Concerning arithmetic, the finding that the brain has a preferred mode of representation bears directly on the teaching of mathematics: it suggests that teachers should build on this spatial system when teaching ordinality and place value. Other aspects of education that have been informed by neuroscience include second language learning, lifelong learning, and early learning (Blakemore & Frith, 2005).

However, a fair and fruitful dialogue among the sciences presupposes a minimum amount of knowledge and familiarity. The current demand for educators’ literacy in neuroscience seems very attuned with Jakob’s arguments (Ansari & Coch, 2006).

In a survey of teachers, almost 90% thought that knowledge of the brain was important, or very important, in designing educational programs (Pickering & Howard-Jones, 2007). In 1999, the Teaching and Learning Research Programme (TLRP) commissioned Blakemore and Frith to review neuroscientific findings that might be of relevance to educators. At the same time, a project on “Learning Sciences and Brain Research” was launched by the Centre for Educational Research and Innovation (CERI) at the Organisation for Economic Cooperation and Development (OECD). Major research and funding institutions from all over the world took part in that attempt: the Sackler Institute (U.S.A.), the University of Granada (Spain), and the RIKEN Brain Science Institute (Japan); the National Science Foundation (U.S.A.), the Lifelong Learning Foundation (U.K.), and the City of Granada (Spain); and INSERM (France) (OECD, 2001). The first phase of the project (1999–2002)

brought together international scientist to review the potential implications of brain research for policy makers. The second phase (2002–2006) focused its activities on three areas, literacy, numeracy, and lifelong learning (Howard-Jones, & Economic and Social Research Council, 2007).

Brain topics, psychological theories, and educational implications

The potential cross-fertilization of neuroscience and education and its inherent limitations are one of the main points of discussion in the educational neuroscience literature (Beauchamp & Beauchamp, 2012). The production of “usable knowledge” (Christodoulou et al., 2009, p. 65) has proven a demanding task for researchers, as it entails an innate danger of misapplication, i.e., oversimplification, misunderstanding or generalization of scientific data (Beauchamp & Beauchamp, 2012).

Jakob’s elaborations form a justified basis for educational implications, given that they cover multiple aspects of learning, both horizontally (evo-devo processes, normal and pathological conditions, structure and function) and vertically (in-depth analyses and formulation of original theories). In addition, one of the most influential schools of educational thought, i.e. the Piagetian, is based on a cognitive theory with biological roots.

Piaget (1964) argued that learning is subordinated to development. In a similar line of thinking, Jakob held the firm belief that cognitive and socio-emotional development go hand in hand with cerebral development in a course he termed “psychogenesis” (Jakob, 1913, 1921, 1935). Thus, he explored its evolution and development in his neurodynamic postulate (for reviews see Théodoridou & Triarhou, 2011, 2012b).

Jakob’s theory on cognitive development could have impact on the formulation of learning theories and practices, as the quest for a mutual understanding among cognitive scientists, neuroscientists, and educators is at the epicenter of current research.

In Jakob’s neurodynamic theory, every system is an arc or circuit, composed of long ramifications or afferent and efferent pathways, “macrodynamics” of charge and discharge, and of a center or an inserted formation of increasing complexity, comprising cells and short fibers that constitute the “microdynamics” or “associative and commissural systems” (López Pasquali, 1965). The first

macrodynamic circuit (reflexes) is only capable of responding in an instant and invariable form. The second macrodynamic circuit (instincts) preserves the information and mounts it up through discharges. In the third macrodynamic circuit, any entering or exiting element becomes registered and furthermore interacts interfocally. Such a system subserves the emergence of “psychism”, i.e. “the neurobiophylactic complex of neuroenergetic reception, assimilation and reaction, which regulates the organism’s vital necessities against variable factors in the external and internal milieu” (Jakob, 1939, p. 8). Psychogenesis crescents in the “neopsychic” stage. Then, three kinds of neurocognitive processes occur: (a) *gnoses*, which secure the conscious orientation in one’s environment; (b) *praxes*, which underlie active individual intervention; and (c) *symbolisms*, which subserve the communication of abstract ideas by means of human language (Jakob, 1921, 1935).

Treating developmental disorders

One of the most important of Jakob’s contributions to education is his effort to establish a biological treatment theory for developmental disorders (Théodoridou, 2011). Jakob (1913) viewed mental retardation as the result of a degenerative psychogenetic process that necessitates a biological treatment. Thereby, the introduction of principles for a biological classification with practical and functional value would be meaningful. Jakob condemned the existing classifications as insufficient and ineffective for the formulation of both psychological and educational intervention.

Still, he acknowledged the contribution of existing classifications (clinical, anatomo-pathological, and educational) to psychology, medicine, and education, respectively. However, he stressed the importance of a functional connection between these aspects on grounds of the dynamic nature of mental retardation. He noticed that each of those aspect and their interactions may influence prognosis in a child with mental retardation, e.g. the time of onset of a disease, the extent of a lesion, individual differences, and the amount and quality of educational opportunities.

On that basis, Jakob (1913) divided normal cognitive and socio-emotional development into the following psychogenetic stages (see also, Théodoridou, 2011):

1. “Psychobiomolecular stage”, characterized by the irritability of the protoplasm.
2. “Psychoneuromolecular stage”, when elementary nervous organization is not differentiated,

although there is a nervous irritability.

3. “Elementary psychoreflexive stage”, signalled by the differentiation of the reflexive, the nuclear, the spinal and the bulbar systems.
4. “Complex psychoreflexive stage”, when the successive maturation of instincts, impulses and subcortical arcs is realized, along with the differentiation of afferent and efferent arcs.
5. “Crepuscular stage”, when the reflexes and functions such as respiration, sucking, some movements and mimicry dominate as primary, diffuse, and preconscious cortical perceptions.
6. “Stage of provisory psychological fixations”:
 - a. “Stage of elementary temporary fixations”, when the superior instincts, affects, active mimicry and combined voluntary perceptions and actions first appear.
 - b. “Stage of complex temporary fixations”, when elements of articulate language, concrete ideas, orientation in the environment in terms of space and time as well as affective and voluntary actions emerge.
7. “Stage of definitive psychoenergetic associations”:
 - a. “Stage of permanent concrete associations”, when an egocentric realism, the formation of personality, actions of affective inhibition, elementary consciousness, as well as the perception of time, space and causality are observed.
 - b. “Stage of elementary abstract associations”, when the conscious personality is formed with elements of self-criticism and egoism; judgment, reasoning and acts of intellectual inhibition are also evident in this stage of infantile analytic empiricism.
8. “Puberty”, when the synthesis of ideas is possible, and aesthetic and ethic tendencies are evident. And finally,
9. “Second puberty”, when thought becomes rational and speculative.

Jakob’s designation of egocentric realism precedes once again a Piagetian concept (see also, Théodoridou & Triarhou, 2011, 2012b). Piaget (1926, 1932) introduced the concept of egocentrism in his early writings (Light, 1983). The roots of the concept of egocentrism can be traced back to Freud’s influence on Piaget, in particular on Freud’s concepts of the “primary process” (i.e., the mode of

functioning in service of the immediate gratification of needs) and the “secondary process” (i.e., the regulation and control of needs to attend to the demands of reality) (Kesserling & Müller, 2011). Piaget (1920) initially distinguished between autistic (i.e. symbolic) and logical, scientific thought. Piaget’s (1920) notion of autistic thought is derived from Bleuler, and is much different from the contemporary use of this term as a designator of a particular developmental disorder (Kesserling & Müller, 2011). The pleasure principle dictates autistic thinking which is “personal, incommunicable, confused, undirected, indifferent to truth, rich in visual and symbolic schemas, and above all, unconscious of itself and by the affective factors by which it was guided” (Piaget, 1928, pp. 204–205). Later, Piaget introduced the concept of egocentrism as an intermediate level between these modes of thought. However, Piaget’s study of his own infants led to a revision of the concept of egocentrism, which from the mid-1930s was conceptualized as a phenomenon that recurs at the beginning of different developmental stages.

Jakob (1913) viewed developmental disorders as energetic and dynamic conditions defined by multiple components. Thus, he stressed the importance of elucidating the internal and external causes of developmental cognitive arrest, and their complex consequences on cerebral growth. He maintained that such knowledge would help scientists to contain the extent and severity of the factors that compromise the learning powers of the brain.

Apart from their biological characteristics, in his 1913 article Jakob further provided the psychological profile that corresponds to each stage. He maintained that “degenerative psychogenesis” runs through the same stages as normal psychogenesis. He further made suggestions for suitable interventions, according to the stage that the child with disabilities falls into. Finally, Jakob discussed the concept of *patopedagogía* (“pathopedagogy”) long before the fields of special and remedial education were formally introduced (Théodoridou, 2011).

In 1940 Jakob, in collaboration with Antonio Scaravelli, published a study of eight siblings from Tupungato with familial mental retardation, deafness and spastic quadriplegia (Jakob & Scaravelli, 1940). Maintaining his interest in disability, Jakob dealt with heredity factors that cause pathological characteristics both from a neurological and from a socio-anthropological viewpoint.

Until the end of the eighteenth century, charity rather than education served as the underlying

guidance for any special provisions for disabled children (Winzer, 1993). Afterwards, some sparse attempts were made for a methodologically sound, science-informed special education by pioneers such as the French physician-educator Jean Marc Gaspard Itard (1774–1838), the French psychologist Eduard Seguin (1812–1880), the Italian physician-educator Maria Montessori (1870–1952), the Belgian teacher and psychologist Jean-Ovide Decroly (1871–1932), and the Soviet defectologists Aleksandr Moiseevich Shcherbin (1874–1934), Lev Semyonovich Vygotsky (1896–1934), and Ivan Afanasevich Sokolyanskii (1898–1960).

The demand for a neuroscience-informed special education (Goswami, 2004) ensued from the unification of the mind, brain, and education sciences under modern attempts defined as neuroeducation (Battro et al., 2008) and educational neuroscience (Petitto & Dunbar, 2004; Szüks & Goswami, 2007). Learning and education can be viewed as a new field of the natural sciences with the entire human life-span as its subject, including various problems such as fetal environment, childcare, language acquisition, general and special education, as well as rehabilitation (Koizumi, 2004). In this line of thought, Ito (2004) suggested that research should aim at providing new knowledge about the pathogenesis of developmental disorders on the solid basis of neuroscience. New knowledge should aid the appropriate assessment and treatment of patients, based on an accurate identification of individual-specific deficiencies, and environmental factors that might prevent children from behaving appropriately. Therefore, it would be helpful in solving problems rooted in antisocial behaviors of students. Further advantages of the adoption of a biological perspective include the timely diagnosis of special educational needs; the monitoring and comparison of the effects of different kinds of educational input on learning; and an increased understanding of individual differences in learning, and the best ways to customize input to the learner (Goswami, 2004).

Conclusion

A polymath, Jakob contributed original ideas to diverse aspects of education and pedagogy. Jakob's organizational skills have been considered exceptional (Papini, 1978). Throughout his career, Jakob became heavily involved in the organization of services, laboratories, clinics and academic departments (Jakob, 1916, 1937, 1943a), and is credited as the father of Argentinian neurobiology and

neurology (Orlando, 1966; Triarhou & del Cerro, 2007), having established an intellectual lineage of distinguished researchers and clinicians that included José Ingenieros, Braulio Moyano and many others.

With his deep understanding of human brain function, he shed light on cognitive development, and consciously aimed at the enhancement of learning theories and practices. Jakob further promoted the right of handicapped children to an appropriate education, paving the path for the grounding of special education on a scientific basis (Jakob, 1913). Impressively, he put forth the idea of teaching a course on “The nervous system and its relationship to education” as early as 1906. Although such a ground breaking idea did not find fertile soil right away, eventually, in 1922, he became one of the first academics to formally teach neurobiology in a School of Education, at the National University of La Plata in Argentina. Thus, Jakob introduced fundamentals of neuroeducation many decades before that discipline was formalized. At the same time, the National University of La Plata should be credited for its pioneering administrative decisions on educational and research policies that rendered such a neuroeducational connection possible. Ninety years after, Jakob’s innovative thinking may still open up new horizons for a neuroscience-informed learning science and interdisciplinarity.

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References

- Allegri RF (2008): The pioneers of clinical neurology in South America. *Journal of the Neurological Sciences* 271: 29–33.
- Ansari D, Coch D (2006): Bridges over troubled waters: Education and cognitive neuroscience. *Trends in Cognitive Sciences* 10: 146–151.
- Baddeley AD (2002): Fractionating the central executive. In: Stuss DT, Knight RT, eds., *Principles of Frontal Lobe Function* (pp. 246–260). Oxford, Oxford University Press.
- Battro AM, Cardinali DP (1996): Más cerebro en la educación. *La Nación*. [Online]. Retrieved from <http://www.byd.com.ar/cereln.pdf> [20 November 2011].
- Battro AM, Fischer KW, Léna P (2008): *The Educated Brain: Essays in Neuroeducation*. Cambridge, Cambridge University Press.
- Beauchamp M, Beauchamp C (2012): Understanding the neuroscience and education connection: Themes emerging from a review of the literature. In: Della Sala S, Anderson M, eds., *Neuroscience in Education: The Good, the Bad, and the Ugly* (pp. 13–30). Oxford, Oxford University Press.
- Blakemore S-J, Frith U (2005): *The Learning Brain: Lessons for Education*. Malden, Massachusetts, Blackwell.
- Christodoulou JA, Daley SG, Katzir T (2009): Researching the practice, practicing the research, and promoting responsible policy: Usable knowledge in mind, brain, and education. *Mind, Brain, and Education* 3: 65–67.
- Churchland P (2008): The impact of neuroscience on philosophy. *Neuron* 60: 409–411.
- Donaldson HH (1895): *The Growth of the Brain: A Study of the Nervous System in Relation to Education*. London, Walter Scott, Ltd.
- Fawcett AJ, Nicolson RI (2007): Dyslexia, learning, and pedagogical neuroscience. *Developmental Medicine and Child Neurology* 49: 306–311.
- Fischer KW, Daniel DB, Immordino-Yang MH, Stern E, Battro A, Koizumi H (2007): Why mind, brain, and education? Why now? *Mind, Brain, and Education* 1: 1–2.
- Fumagalli A, Saredo G (2005): Christofredo Jakob (1866–1956) and the birth of neurology in Argentina. *Journal of the Neurological Sciences* 238 [Suppl. 1]: 160–161.
- Fuster J (2006): The cognit: A network model of cortical representation. *International Journal of Psychophysiology* 60: 125–132.
- Geake J (2006): Educational neuroscience and neuroscientific education: In search of a mutual middle-way. *Learning* 92: 10–15.
- Glick TF (1996): Science in twentieth century Latin America. In: Bethel L, ed., *Ideas and Ideologies in Twentieth Century Latin America* (pp. 287–359). New York, Cambridge University Press.
- González JV (1905): *La Universidad Nacional de La Plata: Memoria sobre su Fundación*. Buenos Aires, Talleres Gráficos de la Penitenciaría Nacional.
- Goswami U (2004): Neuroscience, education and special education. *British Journal of Special Education* 31: 175–183.

- Goswami U (2006): Neuroscience and education: from research to practice? *Nature Reviews Neuroscience* 7: 406–411.
- Gotthelf R (1969): Historia de la psicología en la Argentina, segunda parte. *Revista Latinoamericana de Psicología (Bogotá)* 1: 183–198.
- Halleck RP (1896): *The Education of the Central Nervous System: A Study of Foundations, Especially of Sensory and Motor Training*. New York, Macmillan Company.
- Howard-Jones P, Economic and Social Research Council (2007): *Neuroscience and Education: Issues and Opportunities*. London, TLRP.
- Ingenieros J (1922): *Prinzipien der biologischen Psychologie*. Leipzig, F. Meiner.
- Jakob C (1906): Estudios biológicos sobre los lóbulos frontales cerebrales. *La Semana Médica* 13: 1375–1381.
- Jakob C (1911): *Das Menschenhirn: Eine Studie über den Aufbau und die Bedeutung seiner grauen Kerne und Rinde*. München, J. F. Lehmann.
- Jakob C (1912a): Über die Ubiquität der senso-motorischen Doppelfunktion der Hirnrinde als Grundlage einer neuen, biologischen Auffassung des corticalen Seelenorgans. *Journal für Psychologie und Neurologie (Leipzig)* 19: 379–382.
- Jakob C (1912b): Ueber die Ubiquität der senso-motorischen Doppelfunktion der Hirnrinde als Grundlage einer neuen biologischen Auffassung des kortikalen Seelenorgans. *Münchener Medizinische Wochenschrift* 59: 466–468.
- Jakob C (1913): La psicopatogenia de los niños retardados: Psicogenesis degenerativa y su tratamiento biológico. *Revista de la Asociación Médica Argentina* 21: 1003–1016.
- Jakob C (1916): Encuesta sobre en plan de estudios de medicina y la formación del profesorado universitario. *Revista del Círculo Médico Argentino y Centro de Estudiantes de Medicina* 16: 1–2.
- Jakob C (1921): La teoría actual de las gnosias y praxias como factores fundamentales en el dinamismo de la corteza cerebral. *La Crónica Médica (Lima)* 38: 17–24.
- Jakob C (1922): Sobre tumores teratogénicos del cerebro (A propósito de un teratoma del conducto de Sylvio). In: Junta para el homenaje a Cajal, eds., *Libro en honor de D. S. Ramón y Cajal—Trabajos Originales de Sus Admiradores y Discípulos, Extranjeros y Nacionales*, tomo II (pp. 415–431). Madrid, Jiménez y Molina Impresores.
- Jakob C (1935): La filogenia de las kinesias: Sobre su organización y dinamismo evolutivo. *Anales del Instituto de Psicología de la Facultad de Filosofía y Letras de la Universidad de Buenos Aires* 1: 109–127.
- Jakob C (1937): La enseñanza universitaria de la anatomía cerebral. *Revista de la Asociación Médica Argentina* 51: 799–803.
- Jakob C (1939): *El Neoencéfalo: Su Organización y Dinamismo*. Buenos Aires: Universidad Nacional de La Plata–Imprenta López.
- Jakob C (1941): La función psicogenética de la corteza cerebral y su posible localización (Aspectos de la ontopsicogénesis humana). *Anales del Instituto de Psicología de la Facultad de Filosofía y Letras de la Universidad de Buenos Aires* 3: 63–80.
- Jakob C (1942): La función de la Biología en la Facultad de Filosofía y Letras. *Logos (Buenos Aires)* 1: 159–161.
- Jakob C (1943a): Clínica–Laboratorio. *Revista de la Asociación Bioquímica Argentina* 9: 42–44.

- Jakob C (1943b): *Folia Neurobiológica Argentina, III. El Lóbulo Frontal: Estudio Monográfico Anatomoclínico sobre Base Neurobiológica*. Buenos Aires, Aniceto López-López y Etchegoyen.
- Jakob C (1945): *Folia Neurobiológica Argentina, IV. El Yacaré (Caimán latirostris) y el Origen del Neocortex: Estudios Neurobiológicos y Folkloricos del Reptil más Grande de la Argentina*. Buenos Aires, Aniceto López Editor.
- Jakob C (1946): *Folia Neurobiológica Argentina, V. Documenta Biofilosófica*. Buenos Aires, López y Etchegoyen.
- Jakob C, Onelli C (1913): *Atlas del Cerebro de los Mamíferos de la Republica Argentina: Estudios Anatómicos, Histológicos y Biológicos Comparados sobre la Evolución de los Hemisferios y de la Corteza cerebral*. Buenos Aires, Guillermo Kraft.
- Jakob C, Scaravelli A (1940): A propósito de un caso de ocho hermanos con idiocia, sordomudez y cuadriplejía espasmódica familiar. *Revista Neurológica de Buenos Aires* 5: 283–299.
- Ito M (2004): ‘Nurturing the brain’ as an emerging research field involving child neurology. *Brain and Development* 26: 429–433.
- Koizumi H (2004): The concept of ‘developing the brain’: A new natural science for learning and education. *Brain and Development* 26: 434–441.
- Kesslering T, Müller U (2011): The concept of egocentrism in the context of Piaget’s theory. *New Ideas in Psychology* 29: 327–345.
- Light P (1983): Piaget and egocentrism: A perspective on recent developmental research. *Early Child Development and Care* 12: 7–18.
- Moyano BA (1957): Christfried Jakob, 25/12/1866–6/5/1956. *Acta Neuropsiquiátrica Argentina* 3: 109–123.
- Nazar Anchorena BA, Amaral SM, Alegre PJ (1927): *La Universidad Nacional de La Plata en el Año 1926: Publicación Oficial*. La Plata & Buenos Aires, Casa J. Peuser, Ltda.
- OECD (Organisation for Economic Co-operation and Development) (2001): *Preliminary Synthesis of the Third High Level Forum on Learning and Sciences and Brain Research: Potential Implications for Education Policies and Practices*. Retrieved from <http://www.oecd.org/edu/ceri/15302896.pdf> [22 November 2012].
- Orlando JC (1966): *Christofredo Jakob: Su Vida y Obra*. Buenos Aires, Editorial Mundi.
- Papini MR (1978): La psicología experimental argentina durante el período 1930–1955. *Revista Latinoamericana de Psicología (Bogotá)* 10: 227–258.
- Papini MR (1988): Influence of evolutionary biology in the early development of experimental psychology in Argentina (1891–1930). *International Journal of Experimental Psychology* 2: 131–138.
- Petitto LA, Dunbar K (2004): New findings from educational neuroscience on bilingual brains, scientific brains, and the educated mind. *Conference on Building Usable Knowledge in Mind, Brain, and Education*, 6–8 October 2008, Cambridge, MA.
- Piaget J (1920): La psychanalyse dans ses rapports avec la psychologie de l’enfant. *Bulletin mensuel de la Société Alfred Binet* 20: 18–34 & 41–58.

- Piaget J (1926): *The Language and Thought of the Child*. London, Routledge & Kegan Paul.
- Piaget J (1928): *Judgment and Reasoning in the Child*. New York, Harcourt, Brace and Company.
- Piaget J (1932): *The Moral Judgement of the Child*. London, Routledge & Kegan Paul.
- Piaget J (1964): Cognitive development in children: Development and learning. *Journal of Research in Science Teaching 2*: 176–186.
- Pickering SJ, Howard-Jones P (2007): Educators' views on the role of neuroscience in education: Findings from a study of UK and international perspectives. *Mind, Brain, and Education 1*: 109–113.
- Raichle ME (2002): Foreword. In: Stuss DT, Knight RT, eds., *Principles of Frontal Lobe Function* (pp. vii–ix). Oxford, Oxford University Press.
- Ramón y Cajal S (1906a): Inducciones fisiológicas de la morfología y conexiones de las neuronas. *Archivos de Pedagogía y Ciencias Afines (La Plata) 1*: 216–236.
- Ramón y Cajal S (1906b): Morfología de la célula nerviosa. *Archivos de Pedagogía y Ciencias Afines (La Plata) 1*: 92–106.
- Ramón y Cajal S (1988): *Recollections of My Life* (translated by E.H. Craigie and J. Cano). Birmingham, Alabama, The Classics of Neurology and Neurosurgery Library–Gryphon Editions.
- Stern E (2006): *Educational Research and Neurosciences—Expectations, Evidence and Research Prospects*. Berlin, Bundesministerium für Bildung und Forschung.
- Szűcs D, Goswami U (2007): Educational neuroscience: Defining a new discipline for the study of mental representations. *Mind, Brain, and Education 1*: 114–127.
- Talak AM (2008): Christofredo Jakob: La tradición neurobiológica en la primera psicología en Argentina. *VI Encuentro de Filosofía e Historia de la Ciencia del Cono Sur Montevideo*, 27–30 May 2008, Montevideo, Uruguay.
- Théodoridou ZD (2011): *Christfried Jakob on the cerebral cortex: Neurobiological, neurophilosophical and neuroeducational concepts* (Unpublished Doctoral Dissertation). Thessaloniki, Greece, University of Macedonia.
- Théodoridou ZD, Triarhou LC (2009): Fin-de-siècle advances in neuroeducation: Henry Herbert Donaldson and Reuben Post Halleck. *Mind, Brain, and Education 3*: 117–127.
- Théodoridou ZD, Triarhou LC (2011): Christfried Jakob's 1921 theory of the gnoses and praxes as fundamental factors in cerebral cortical dynamics. *Integrative Psychological and Behavioral Science 45*: 247–262.
- Théodoridou ZD, Triarhou LC (2012a): Challenging the supremacy of the frontal lobe: Early views (1906–1909) of Christfried Jakob on the human cerebral cortex. *Cortex 48*: 15–25.
- Théodoridou ZD, Triarhou LC (2012b): Christfried Jakob's late views (1930–1949) on the psychogenetic function of the cerebral cortex and its localization: Culmination of the neurophilosophical thought of a keen brain observer. *Brain and Cognition 78*: 179–188.
- Triarhou LC (2008a): Centenary of Christfried Jakob's discovery of the visceral brain: An unheeded precedence in affective neuroscience. *Neuroscience and Biobehavioral Reviews 32*: 984–1000.
- Triarhou LC (2008b): The books of Christofredo Jakob: Lasting treasures of evolutionary neuroscience. *Society for*

Neuroscience Abstracts 38: 221.16.

- Triarhou LC (2009): Tripartite concepts of mind and brain, with special emphasis on the neuroevolutionary postulates of Christfried Jakob and Paul MacLean. In: Weingarten SP, Penat HO, eds., *Cognitive Psychology Research Developments* (pp. 183–208). Hauppauge, New York, Nova Science Publishers.
- Triarhou LC (2010a): Final publications of Christfried Jakob: On the frontal lobe and the limbic region. In: Flynn CE, Callaghan BR, eds., *Neuroanatomy Research Advances* (pp. 165–169). Hauppauge, New York, Nova Science Publishers.
- Triarhou LC (2010b): Revisiting Christfried Jakob's concept of the dual onto-phylogenetic origin and ubiquitous function of the cerebral cortex: A century of progress. *Brain Structure and Function* 214: 319–338.
- Triarhou LC, del Cerro M (2006a): An early work [1910–1913] in *Biological Psychology* by pioneer psychiatrist, criminologist and philosopher José Ingenieros, M.D. (1877–1925) of Buenos Aires. *Biological Psychology* 72: 1–14.
- Triarhou LC, del Cerro M (2006b): Semicentennial tribute to the ingenious neurobiologist Christfried Jakob (1866–1956). 1. Works from Germany and the first Argentina period, 1891–1913. *European Neurology* 56: 176–188.
- Triarhou LC, del Cerro M (2006c). Semicentennial tribute to the ingenious neurobiologist Christfried Jakob (1866–1956). 2. Publications from the second Argentina period, 1913–1949. *European Neurology* 56: 189–198.
- Triarhou LC, del Cerro M (2007): Christfried Jakob (1866–1956). *Journal of Neurology* 254: 124–125.
- Tsapkini K, Vivas AB, Triarhou LC (2008): 'Does Broca's area exist?' Christofredo Jakob's 1906 response to Pierre Marie's holistic stance. *Brain and Language* 105: 211–219.
- Vivas AB, Tsapkini K, Triarhou LC (2007): Anatomico-biological considerations on the centers of language: An Argentinian contribution to the 1906 Paris debate on aphasia. *Brain and Development* 29: 455–461.
- von Economo C, Koskinas GN (1925): *Die Cytoarchitektonik der Hirnrinde des erwachsenen Menschen: Textband und Atlas*. Wien, J. Springer.
- Winzer MA (1993): *The History of Special Education: From Isolation to Integration*. Washington, DC, Gallaudet University Press.

Figure captions

Figure 1. Bust of Christofredo Jakob at the Pathology Laboratory, Moyano Psychiatric Hospital, Buenos Aires. Credit: http://www.flickr.com/photos/theodor_meynert/4695367482.

Figure 2. One of Jakob's main interests was developmental neurobiology, human and comparative. (A) Lateral view of left cerebral hemisphere in human embryos at four, five, six and eight months of gestation, showing the progressive gyration (Jakob, 1941, p. 428). (B) Lateral view of left cerebral hemisphere in a fetus at a gestation age of 5½ months (Jakob, 1941, p. 433). (C) Midsagittal facies of right cerebral hemisphere in a human fetus at 5 months of gestation (Jakob, 1941, p. 433). From the private archive of L.C. Triarhou. Copying, redistribution, or retransmission without the author's express written permission is prohibited.

Figure 3. Roster of administrative officers and members of the Faculty of Humanities and Educational Sciences, National University of La Plata (Nazar Anchorena et al., 1927, pp. 20–21). The Faculty roster includes some remarkable names. The Dean, Doctor (probably Law Doctor) Ricardo Levene, professor of Argentinian History and Sociology, was the author of the most respected and widely read *Historia de la República Argentina* available in the mid-20th century. Alejandro Korn (1860–1936) was an Argentine physician, psychiatrist, philosopher, reformist and politician. For 18 years, he was the director of the psychiatry hospital in Melchor Romero (a locality of La Plata in Buenos Aires), named for the city. He was the first university official in Latin America to be elected, thanks to the students' vote. He is considered the pioneer of Argentine philosophy. Along with Florentino Ameghino, Juan Vucentich, Almafuerte and Carlos Spegazzini, he is considered to be one of the five wise men of La Plata. He was still remembered with respect in the university days of one of the authors [MdC] as a man of extraordinary culture and liberal ideals. Rafael Alberto Arrieta, one of the best known and respected writers around 1945–1964 [MdC]. Leopoldo Lugones: If Arrieta was the man of letters that saw the present and dreamed the future, Lugones was the man that saw the present and wanted to live in the past. A respected poet, we reluctantly have to admit. His son Leopoldito, as he was sarcastically called, became the chief torturer of the Argentinian police, or so it was said. Apparently he wanted to restore “la Argentina de la Cruz y de la Espada.” From the private archive of L.C. Triarhou. Copying, redistribution, or retransmission without the author's express written permission is prohibited.

Figure 4. The National University of La Plata, Argentina in 1926. *Upper left:* The School of Humanities and Educational Sciences. Central building of the University. *Upper right:* Jakob's Laboratory of the Nervous System at the School of Humanities and Educational Sciences. *Lower:* Jakob's Laboratory of Pathological Anatomy and Physiology at the School of Medical Sciences viewed from two different angles (Nazar Anchorena et al., 1927, pp. 297, 309, 350). From the private archive of L.C. Triarhou. Copying, redistribution, or retransmission without the author's express written permission is

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Figure 5. Jakob's neurobiology textbooks, upper row, published under the auspices of the School of Education at La Plata: the "Elements of Neurobiology," *left*, and "The Frontal Lobe," *right* (Jakob, 1923, 1943b). Jakob's booklets on the nervous system, lower row, based on his lectures at the School of Education in La Plata: "The Subcortical Organization of the Central Nervous System," "The Neencephalon, its Organization and Dynamics," and "Ontogeny of the Human Nervous System" (Jakob, 1936, 1939, 1940). From the private archive of L.C. Triarhou. Copying, redistribution, or retransmission without the author's express written permission is prohibited.