The search for the origins of genius in the brain: The Pantheon of Brains

E. García-Albea[1], J. García-Albea[2]

[1]Head of department of Neurology. Hospital Universitario Príncipe de Asturias. Senior lecturer, Universidad de Alcalá, Alcalá de Henares, Spain.
[2]Department of Psychiatry. Hospital Clínico Universitario de San Carlos, Madrid, Spain.

ABSTRACT

The history of the brain has undoubtedly been one of the great challenges of human science, comparable only to understanding of the universe. Both disciplines are still incomplete and their structure and functioning are still unknown.

Ever since Hippocrates' superb explanation in his work on the "sacred disease", many have been the vicissitudes and confrontations around this angelic yet diabolical viscus. The powers that be have often interfered through theoretical manipulation.

In the early 20th century, at a time when anatomical, physiological, and clinical knowledge were in exponential growth, the cult of the brain reached its zenith (Wilhelm Erb's "brain-mythology"). In what was then the Soviet Union, the Pantheon of Brains was established to house the brains ("man is his brain") of the country's most popular figures. Stalin, responsible for founding the institution, wanted to get ahead of the initiative of collecting brains which was taking place in medical and neurological centres the world over. The Moscow Pantheon is home to the brains of such personalities as Lenin, Eisenstein, Chekhov, and Pavlov. The institution, initially intended to emulate the Pantheon in Paris, deteriorated following the collapse of the Soviet Union; this decline continued until its recent rehabilitation. This brief monograph aims to recount this singular process.

KEYWORDS
Brain, history, neuropathology, brain collection, phrenology, animal magnetism

Introduction

The history of the brain is undoubtedly exciting, and as full of highs and lows, eccentricities, and myths, as the history of science itself. This illustrates the extraordinarily difficult nature of the brain, the influence of contemporary understanding of nature and the supernatural over its interpretation, and the unavoidable eagerness to speculate about the organ. We should mention that even today, in our century, we are yet to develop a full, sufficient explanation of the brain's functions and how they are performed. However, we live today in an "erudite" ignorance, not a base one. The vicissitudes in the advancement of science from its very early days have legitimated such events as the emergence of Hellenic medicine (Hippocrates) and the identification of a lesion causing a type of language disorder (Broca). These events have helped accelerate new contributions, as well as leading to dogmatic setbacks (cranial phrenology, animal magnetism, psychoanalysis, etc.). However, these many highs and lows have ultimately resulted in significant advances in our understanding of this complex anatomical piece.

This paper aims to summarise this singular historical period when our knowledge of the brain seemed to have reached its peak, allowing us finally to resolve its enigmas and to understand the reasons residing in the brain for human variability: from the born criminal to the saint, from the greedy politician to the genius, able to change the course of human history.

Corresponding author: Dr Esteban García-Albea
E-mail: egalbearistol@salud.madrid.org

Received: 13 January 2017 / Accepted: 18 April 2017

In the early 20th century, Bekhterev inaugurated a centre which would house the brains of the most prestigious deceased personalities of the Soviet Union, including Bolshevik-era politicians, scholars, and artists. This Pantheon would try to compete with its namesake in the French capital, to become an internationally important institution, a temple where the neurological bases of talent and genius would be established: the Pantheon of Brains.

Background

In ancient cultures, where reality was impenetrable without religious explanation (demons, gods, the afterlife, evil, or natural phenomena such as volcanoes or storms), empirical medical knowledge was relatively advanced: examples are the ancient Egyptian descriptions of craniovertebral trauma, brain catheterisation, or the presence of cerebrospinal fluid (Edwin Smith's papyrus).[1] Also surprising is the widespread use of trepanation (studied in Spain by Campillo, in the context of Balearic Talaiotic culture) almost throughout antiquity. Something powerful was inside that bony structure and had to be taken out; some evil being, as was the case in epileptic or migraine subjects ("*le crâne peruvien*", Broca, 1867),[2] was torturing the patient. The brain, then, was the seat of deities and harpies, or of the great virtues of the individual. We should mention the great epidemiologist Carleton Gadjusek (1923-2008), who was awarded the Nobel prize in 1976. He travelled from Maryland to study kuru, a disease which severely affected gait and was spreading through the villages of New Guinea. The disease was believed to be a hereditary condition, as it occurred in members of the same family. In a ritual that followed the death of a Papuan warrior, his descendants would remove and eat the brain to inherit the dead warrior's virtues. But Gadjusek had a different idea. The disease was in the warrior's brain and was transmitted during the ritual. Contravening all international rules, he procured a diseased brain, secreted it in a suitcase and smuggled it to the United States, where he could study it (spongiform encephalopathy) and transfer the disease to a chimpanzee (transmissible encephalopathy). Here, we find two interpretations of the brain: an ancient one, acclaiming the dignity of the brain for holding the virtues of the ancestor, which may be transmitted as spiritual nourishment; and a more recent, 20th-century interpretation, according to which the disease was caused by small protein particles with an abnormal structure (prions, according to Prusiner) which could develop, fatally, in another brain.[3,4]

We will now turn to Classical Greece and its colonies in Asia Minor. Significant political and social changes would determine a historical shift with huge consequences for humanity. From the 5th century BCE (the time of Pericles), the Greeks had the noblest of missions: to take the "chaos" created by magicians who spurned nature, whose immediate empirical observations were distorted by tradition and superstition, and to transform it into a "cosmos": an attempt to discover human nature and add *theoria* (a cause explanation) to *autopsia* (the act of seeing for oneself), allowing the sciences to develop. This is the leap from *mythos* to *logos* (Nestlé). We can do away with rigid, dogmatic explanation and discover the "mysteries" of nature, including those of man himself ("know thyself") or even the brain.

Ars medica, the medical vocation (*techne iatriké*), in which physicians "know the reasons of the things which are done," in the words of Aristotle, radically rejects any magical or religious reference; it focuses on nature, it is rationalised, and for the Greeks, it takes on a form, a full intellectual dignity, of its own. A significant achievement. The time of medicine had come: the brain would take the honourable place it deserved, representing a new universe for physicians and scholars until the present day. Hippocrates selects a very special disease, epilepsy, and writes a small treatise, *De morbo sacro* (*Morbus Sacer)*, barely 50 pages long and written in a doctrinal style which is still relevant today. This represents for medicine and for science in general what the Parthenon does for architecture: "It is thus with regard to the disease called Sacred: it appears to me to be nowise more divine nor more sacred than other diseases, but has a natural cause ..."[5]

In this work, he masterfully details the functions of the brain:

> Men ought to know that from nothing else but the brain come joys, delights, laughter and sports, and sorrows, griefs, despondency, and lamentations. And by this...we acquire wisdom and knowledge, and see and hear, and know what are foul and what are fair, what are bad and what are good, what are sweet, and what unsavory... And by the same organ we become mad and delirious, and fears and terrors assail us, some by night, and some by day, and dreams and untimely wanderings, and cares that are not suitable, and ignorance of present circumstances, desuetude, and unskilfulness. All these things we endure from the brain, when it is not healthy, but is more hot, more cold, more moist, or more dry than natural, or when it suffers any other preternatural and unusual affection.[5]

Emotional and cognitive or rational activity, pathology of the emotions and of reason, sensory functions (not only vision, also discrimination) and mental illness are systematically included in this definition. There could be no better or more succinct way to express it. The humoral or mood theory survived, albeit with substantial modification, for more than 1500 years; Hippocrates had already warned that the path of science is "long and convoluted", and this monograph constitutes proof that he was right.[5] The Middle Ages represent an important setback to knowledge of the brain. The epileptic patients who were so attentively studied by Hippocrates are again considered to be possessed (Gospel of Mark, IX, 14-29; Matthew, XVII, 14-20; Luke, IX, 37-43), and physicians became heretics, setting the doctrine of Christ against the worship of Asclepius (Tertullian). There are exceptions, such as Schola Medica Salernitana or the medicine of Al-Andalus.

The modern era saw the emergence of an enduring theory which would make it necessary to closely observe this mysterious organ: the idea that human variability originates in the brain. Different brains, different behaviours. Where was the difference? Was it in the intertwining structures of the cortex, or perhaps in the ventricles? This question would give rise to a great deal of speculation. Two Spanish physicians from the 16th and 17th centuries should be mentioned: Juan Huarte de San Juan from Navarre, and Esteban Pujasol from Aragón.

Censorship by the Inquisition meant that Huarte met difficulties publishing his work *The Examination of Men's Wits,* subtitled *in which by discovering the varietie of natures, is shewed for what profession each one is apt, and how far he shall profit therein* (Baeza, 1575). Huarte's initiative in identifying differences and finding a cerebral explanation for them captured the attention of European intellectuals.

> To the end that artificers may attain the perfection requisite for the use of the commonwealth, me thinketh (Catholic royal Majesty) a law should be enacted, that no carpenter should exercise himself in any work which appertained to the occupation of a husbandman, nor a tailor to that of an architect, and that the advocate should not minister physic, nor the physician play the advocate, but each one exercise only that art to which he beareth a natural inclination, and let pass the residue.[6]

In a display of imagination and clairvoyance, and with little previous work to which to refer, he organised the three great cognitive functions or "rational generative potencies" (memory, reasoning, and imagination, following proposals made by Galen in the second century) and located each of them close to a ventricle (the "three brain ventricles"). He also confirms "that Theory of the Laws pertains to the memory; pleading causes and judging them (which is the practic) to the understanding; and governing of a Commonwealth, to the imagination".

In the same way that Hippocrates used his treatise *De morbo sacro* to ask Athenians to ignore the voice of charlatans, Huarte (from this pragmatic point of view) appeals to the princes and the academies of the different kingdoms to identify and train those people with "wit" (innate virtue) in a certain vocation. For Huarte, the major functions of the brain are imagination, understanding, and memory, with the predominance or harmony of these being apparent in a person's aptitude for one vocation or another, which depends in turn on the humoral temperaments. Understanding is an "organic potency," located in the ventricular depths of the brain; this is a humoral and materialist vision challenging one of the basic religious dogmas: the concept of the immortal soul. As we can see, the brain had always had the attention of the Spanish Inquisition (although not the censors, in this case), who tried to prevent philosophers and physicians opposed to dogma from addressing this mysterious structure.

Esteban Pujasol (*Filosofía sagaz y anatomía de ingenios*, 1637) offers one of the first (localisationist) phrenological maps (Figure 1). Fantasy and imagination are located in

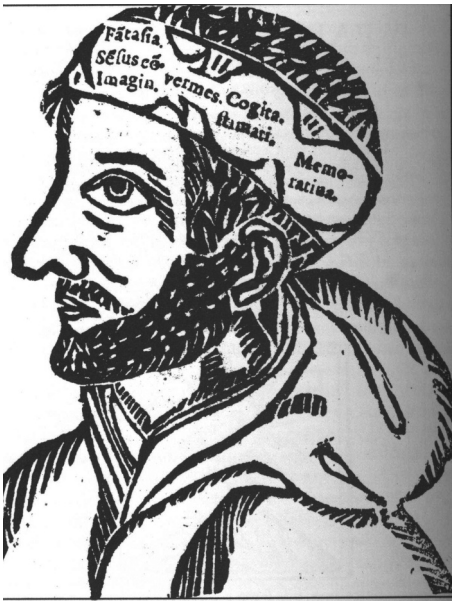

Figure 1. Phrenological brain model by Esteban Pujasol.

the anterior (frontal) ventricle, knowledge in the medial ventricle, and memory in the posterior ventricle. These contributions are not as important as those of Hippocrates, but they represent the first steps towards establishing the brain's functions and their anatomical seats. This subsequently gave rise to fruitless speculation, and is still far from being achieved, despite the advances offered by modern imaging techniques, such as functional magnetic resonance. In any case, localisation of "talent" and "intelligence" in the brain, an endeavour of such great interest among the scientists, politicians, and artists of the 19th and 20th centuries, began to take form as a theory.

We will now pass by certain other historical events, such as the advances in the knowledge of brain anatomy (perhaps the least accomplished chapter of Vesalio's *De Humani Corporis Fabrica*), contributions from clinical observation (Willis), or the advances made as a result of Fritsch and Hitzig's discovery of motor localisation in dogs' brains after galvanic stimulation, and turn our attention to Franz Joseph Gall, whose thought was too advanced for the Germany of his time. Gall was born in Tiefenbrunn (Germany) on 9 March 1758 and received strict medical training in Strasbourg and the flourishing Vienna School, where he gained extensive knowledge of both anatomy and medicine (Figure 2).

As an adolescent, Gall is said to have observed many times that his fellow students, young people with a rich and fluent command of language and prodigious memories also had bulging, baggy eyes (*yeux de boeuf* and *yeux pochetés*). This observation led him to undertake additional research. This is where it began. Gall reasoned that the highly developed frontal lobes in these articulate individuals exerted pressure on the eye sockets, causing the eyes to protrude. Careful examination of the cranium (cranioscopy) thorough palpation (they were called 'skull-fondlers') and reflection on correlations between the anatomical features observed or felt and the patient's noteworthy behavioural traits would reveal the brain's functions. Instead of the four mental faculties recognised by philosophers at the time (memory, judgement, imagination, and reflection), he created a speculative list of 27 faculties together with a topographical map of the skull. In this array of 'organs', physical love, for example, was assigned to organ number 1 at the occipital level (and attributed to hypertrophy of the cerebellum). Organ number 5, on the temporal bone, reflected murderous tendencies; identifying this area would have a major impact on legal medicine.

Figure 2. Franz Joseph Gall

Gall establishes a well-structured hypothesis which has endured until today: the brain possesses specific areas that correspond to specific functions. The great challenge consists in precisely delimiting these areas and their specific functions (Figure 3). In the first public presentation of his ambitious theory, he told his patron:

> My purpose is to ascertain the functions of the brain in general, and those of its different parts in particular; to show that it is possible to ascertain different dispositions and inclinations by the elevations and depressions upon the head; and to present in a clear light the most important consequences which result therefrom to medicine, morality, education, and legislation a word, to the science of human nature.[7]

What more could one want? This is an exploratory finding and a theory with an apparently empirical base, which would enable human variability to be observed in all its dimensions. Phrenologists believed that the skull, with its elevations and depressions, was nothing more than a mould, a faithful reflection of the varying sizes and shapes of brain. The areas (organs) with developed and hegemonic functions are larger, compressing the endocranium, and may be visible as in relief when directly observing the head. These faculties, randomly established (amativeness, phylogenesis, concentrativeness, destructiveness, etc.), numbered (12, 21, 35, 39, etc., according to the author), and unexplained by psychological theory, are correlated with the corresponding brain "organs". This

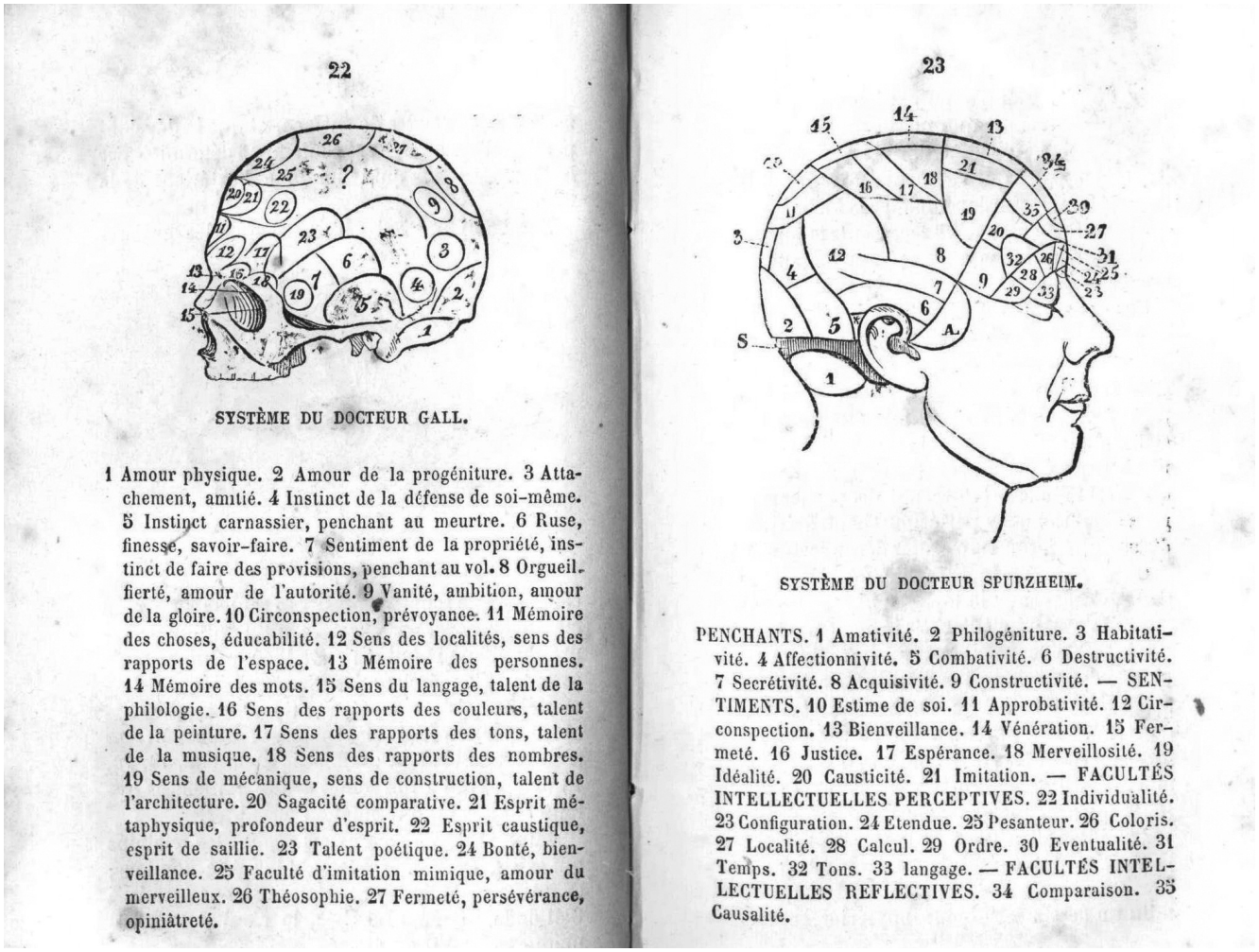

Figure 3. Phrenological maps by Gall and Spurzheim

model was highly speculative and its empirical basis was limited to one or two cases, or a figure in a painting, the asymmetrical head of a servant, or the contours of the sculpted head of a Roman tyrant. Only "born criminals", and not "occasional" ones, showed common features, according to the empirical criminologists, led by the founder of criminology Cesare Lombroso, who examined hundreds upon hundreds of heads of criminals. This intellectual from Pavia was interested in murderers' lack of penal responsibility, considering them to be a missing link in Darwin's theory of evolution. Furthermore, genius does not escape Lombroso's speculation; in his book *Genius and Madness,* he explains that all geniuses are insane and that the genius is an abnormal individual, and details a new psychological thesis: from genius to madness and from madness to genius is but a short step.

However, despite all the speculative effort, the content of the skull was yet to reveal its mysteries. Another ambitious and provocative thesis on a basic way to become unwell (*De planetarum influxu in corpus humanum*), formulated by Franz Anton Mesmer (1734-1815), establishes that the brain contains a reservoir of a universal magnetic fluid, and barely anything else. But the manipulation of this fluid by an expert ("magnetic passes") may heal many diseases. The "animal (and not mineral) magnetism" in its course would connect with psychoanalytical suggestion, hysteria, and its many variations. Diseases, or at least many diseases, are located in the "nerves" and are caused

when these tighten, vibrate like a guitar string, or are crossed by imponderable fluids.

Finally, we shall examine the positivist Paris of the second half of the 19th century, abuzz with faith in science and the religion of facts. Events would develop quickly. Language was the main topic of discussion on both banks of the Seine. As Gall had anticipated, it was imperative to locate the seat of language in the brain. Furthermore, the concepts of intelligence and genius still held topical currency. "We should measure brain volume and forget about specific areas; that could be the desired parameter." "Who is the most intelligent man in France?" In fact, a group of French scientists tried to exhume the corpse of Georges Cuvier, "the most intelligent man in France" and the father of comparative anatomy, to measure his cranial capacity. Cuvier's widow refused to allow her husband's body to be desecrated, but she did offer a solution. She had kept Cuvier's hats, allowing the scientists to measure the cranial perimeter. A certain excitement surrounded these events: indeed, all scientists believe they are living unique, exceptional moments in history. Parisian hatters also wanted to participate in the adventure. However, brain volume was not the empirical data they sought. The head of the naturalist was no larger or smaller than the Parisian average.

Meanwhile, a young surgeon who was very talented as anatomist was on the brink of the greatest contribution to knowledge of the brain since Hipprocrates: this man was Pierre Paul Broca (1824-1880), from Bordeaux. It was chance that brought together several situations before this exceptional paleontologist, who had been examining skulls for many years. Broca refused to accept "that some of his contemporaries should consider brain convolutions as simple, random folds comparable to the chaotic flexuosities of intestinal loops". The echoes of Gall's theories could still be heard in scientific academies and societies. Juan Bautista Bouillaud took the helm of the localisationist approach; which was subsequently passed on to his loyal son-in-law Aubertin, who had to confront Flourens, the leader of "spiritualists". The situation had become tense, as depicted by the outstanding writer and neurologist Pierre Marie:

> The localisation of language has become a political issue. The conservative old school maintains that the brain functions like a single machine. On the other hand, young liberals and republicans are convinced that the two hemispheres of the brain host different parts responsible for specific functions. The authorities took sides. The battle has begun with the spiritualists on one side and the materialists on the other (since this is the designation they tried to assign to free-thinkers). The students' political passions have been aroused just as thoroughly as if brain localisation were part of a republican dogma.[8]

The countdown had begun for a new discovery soon to be made. This would be a date to remember. Broca, a surgeon of the hospitals of Paris, was urged on 12 April 1861 to go to Bicêtre Hospital to see a patient, a monsieur Leborgne, who was suffering with a "diffuse, gangrenous phlegmon", forewarning of the patient's death. Broca was fascinated by Leborgne's loss of the ability to speak: he was able only to utter a monosyllabic word, "tan", for which reason he received the name Monsieur Tan. However, the patient's verbal comprehension and "intelligence" were normal and no paralysis of the bucco-phonatory muscles was observed. This was a case of an absence of articulated language (aphemia), and the patient's brain should show a damaged area. In fact, monsieur Leborgne died, as expected. Broca performed the autopsy that same day. As though it were a pharaonic treasure found in an excavation, he opened the skull and removed the brain with extreme excitement, placing it into a flask of alcohol. He spent the whole night observing and describing the sacred piece. Wasting no time, he attended the weekly meeting of the Anthropological Society of Paris the next day. He slowly took the stand, and with a trembling voice, thoroughly described his findings from the surface of the piece. He had made no cut. As Pierre Marie writes, he did not want to use the "sacrilegious knife". The bells would have stopped ringing, with silence taking hold over Paris: "Most of the frontal lobe of the left hemisphere is softened; the convolutions of the orbital lobe, although they showed atrophy, preserve their shape..." And this ten-line paragraph ends by saying: "All this made us think that in this case, the lesion to the frontal lobe caused the loss of speech..."

A new law of nature had been laid out for posterity: "articulate" language is located on the posterior third of the left third frontal gyrus.

The brain was kept in the Musée Dupuytren (established by Mathieu Orfila, from Menorca), which was located in the refectory of the former Cordeliers Convent. After a long struggle, the lesioned mass can be found fully preserved (flask 56) in the Musée d'Histoire de la Médecine, rue L'École de Médecine, a temple and museum of French medicine in Paris (Figure 4).

After the initial shock, and despite many charges against Broca (who was denounced for "materialism and [...] for corrupting the youth" in the words of Carl Sagan), neurologists found that the path to progress was clear and established that autopsy should become the standard procedure for detailed study of the brain in the context of any behavioural or sensory-motor disorder. The brain still held many surprises. New phrenological maps emerged, such as the one by Karl Kleist (1879-1960), with more than one hundred cortical "centres". Erb had already described the "myth of the brain". A persistent materialist outlook overcame ideology, and French radical materialists insisted on demonstrating the non-existence of the soul. Emile Zola had envisaged the brain locked in a glass skull, open to observation by the general public (1895). The Société d'Autopsie Mutuelle was created in 1876; its members would bequeath their brains for the advancement of science (Figure 5). Furthermore, the wars raging in Europe and the extraordinary morbidity and mortality of the troops due to shrapnel wounds of the brain meant

Figure 5. La Société d'Autopsie Mutuelle

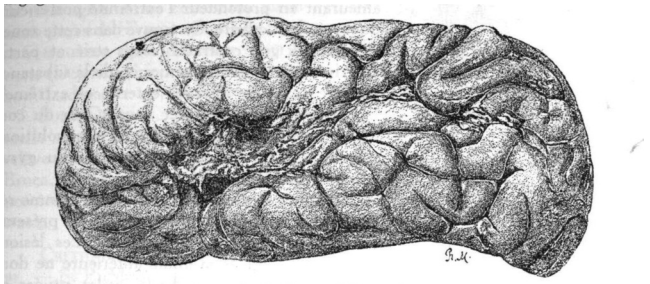

FIG. 35. — *La première autopsie de Broca. L'hémisphère cérébral gauche de Leborgne* (dessin de P. MARIE).

Figure 4. Drawing of Leborgne's brain by Pierre Marie (above). Photograph of its current state (below).

boundless growth in the number of brain syndromes and localisations. The brain had triumphed. *Homo sapiens* had been replaced by H*omo cerebralis*. But nature does not offer easily formulated theories; Von Monakow, Jackson and Pierre Marie went back to work, considering connections between centres, reflexes, excitation and inhibition, pathways and circuits between centres and cortico-subcortical circuits, rather than only the centres themselves. In addition, we should note such advances in histological knowledge (fine vision) as the identification of neurons (Cajal) and the cyto- and myeloarchitectonic maps (Brodmann, Economo, Oskar and Cécile Vogt) enabled by the development of aniline staining techniques. At the International Congress of Medicine held in Madrid in 1903, which reflects the medical reality of that time, the nervous system arose as the main focus of science. There, Cajal explained the histology of the thalamus, and Pavlov his conditioned reflex theory. The way seems to have been paved to obtain not only the "butterflies of the soul" (Cajal), but also the "neurons of intelligence". This is a general call not only for pathologists to reveal the anatomical basis of mental disorders, but also for psychologists, anthropologists, artists and politicians to solve the enigmas of the brain, the reasons for the human variability described by Huarte de San Juan. A call to fill hospital cabinets with brains for study. The process was underway.

Many "brain institutes" were founded; these would house thousands of viscera for scientific study. The great med-

ical event is now the autopsy. We should remember an ironic saying which spread through Central Europe, defining the therapeutic nihilism of Skoda, and the prestige of the pathologist Rokitansky: "the highest aspiration of patients is to be diagnosed by Skoda and have their diagnosis confirmed by Rokitansky at necropsy". But most important was the need to collect "*des cervaux des genies*".

In addition to this practice, biological samples were collected by all nations and scientific institutions for several centuries. These traditions also reached Latin America, where at least two museums were founded: one in Lima, with more than three hundred brains (Museo de Neuropatología) and another in Buenos Aires (Museo de Patología de la Universidad de Buenos Aires). In Barcelona there were more than 20 anatomical collections, some consisting of children's brains and others including wax figures, of which most disappeared during the Civil War. As if they were stamps, institutions exchanged pieces and marketed the most outrageous specimens. Some museums diversified the samples on display and included, with the permission of science, wax "anatomical Venuses", naked, naturally, sometimes with the skin lifted to show the content of the intestines, or showing the damage caused by syphilis. These figures ended up being displayed in fairground stalls. On Barcelona's Parallel avenue, the Roca Museum (specialising in monsters) was a famous establishment; its collection was sold in the Mercantic de Sant Cugat antique market to the Belgian Leo Coolen and is now kept in Antwerp. Madrid also had several museums (the Universidad Complutense alone had 17 museums), which mostly housed wax figures or autopsy samples collected by the Faculty of Medicine (Museo Javier Puerta of the Univerdad Complutense in Madrid). These included skulls and figures from the golden years of the Royal College of Surgery of San Carlos (1787), founded by Gimbernat during the reign of the enlightened king Charles III. Most contributions came from Olóriz (1855-1912) (Cajal's adversary in chess), who collected 2250 skulls, each one with a note explaining its characteristics. The museum, which has miraculously survived in the always-turbulent Madrid, is currently located in a department of the Faculty of Medicine of the Universidad Complutense (a battlefront during the Civil War) and can be visited by those with the patience to find it. The collection includes wax figures made by Spanish Enlightenment artists with the participation of Florentine artists, wax sculptors, and anatomists. Most of the pieces conserved today depict the brain and obstetric and gynaecological subject matter. The museum has frequently been on the verge of disappearance, with the vicissitudes of Spain and poor management of the institution (pieces were distributed between different University chairs) impacting its struggle to survive. The Chair of Anatomy Javier Puerta (1946-2004) made the greatest efforts to preserve and improve the museum collections; therefore, he truly merits the museum bearing his name. With extremely limited funds available, the pregnant Venuses are currently in the care of restorers from the School of Arts.

The Anthropological Museum (ethnological museum) houses the collection of Pedro González de Velasco (1815-1882), a prestigious Spanish collector of scientific objects, which is of special interest. Among the museum's most valuable pieces were the skeleton of the "giant from Extremadura", which he seemingly bought when he was alive, and the skeleton of a French farmer, of a silvery colour due to severe mercury poisoning. It is said that Dr González de Velasco could not accept the death of his 15-year-old daughter, so he mummified her body to keep it in the museum and to take it to the Retiro park or to bullfights.

The goal was to collect brains of geniuses to measure them, especially to weigh them and to perform the necessary anatomical analysis, to preserve them as antique pieces and to develop a satisfactory theory on this new phrenology, which ultimately never took form.

An initial anecdote on the prestigious French writer Anatole France (1844-1924), who was the author of the novel *The Gods Are Athirst*, among others, and received the Nobel Prize for Literature in 1921 (a year before Jacinto Benavente), illustrates the "myth of the brain" we are dealing with. When he died, his brain weighed barely 1000 grammes, a value far below the mean. The surgeon Guillaume-Louis and his assistant Dubréuil-Chambardel, who held this brain in their hands and placed it on the scale, wrote that: "It was the most beautiful brain a man could dream of or see. Its gyri were wonderful, the curves superb. It belonged to a unique species." Nature had granted Anatole France a "beautiful", although light, brain, "a piece of jewellery".

However, it was in Russia where brain collection knew no limits.[9] There was a long tradition of neuroanatomical studies in all the important Russian universities (Moscow, St. Petersburg, Kiev, Kazan, and Tomsk). Tsar Peter the

Great, a great collector, founded the Kunstkamera in St. Petersburg (1714), with 2000 anatomical specimens and two million pieces. Dead, malformed newborns had to be sent to the museum. The interest of Russian neuroanatomists was not new: the Anatomical Museum of the University of Moscow had been founded in 1783. The Moscow professor Zernov (1843-1917), after a detailed study of the convexity of the brain at that university, went against Lombroso and the new enlightened generation, concluding that all brains were the same, regardless the nationality or race.[10] The communist and Christian idea of equality was being imposed. Many Russian neurologists distinguished themselves during that period; examples are Betz (1834-1894), professor at the University of Kyiv and discoverer of the neurons of the motor cortex (Betz cells), or Vladimir Bekhterev (1857-1927), founder of the Psychoneurological Research Institute in St. Petersburg (1907), which aimed to compete with Moscow institutions. Bekhterev elaborated the idea, which is mostly valid today, that the brain is a "bio-social" entity and that in order for it to be understood, a multidisciplinary effort should be made by psychologists, psychiatrists, and neurosurgeons. He was a disciple of the German scientist Wundt (the father of experimental psychology) and of the master of masters, the French neurologist Charcot. He described ankylosing spondylitis (or Bekhterev disease). In summary, these were the optimal conditions to erect the Pantheon of Brains.

Bekhterev, in opposition to Zernov, was the great promoter of studying brain differences in Russian scholars. In 1909, he published the characteristics of the brain of Mendeleev (1834-1907), the brilliant chemist who created the periodic table of the elements. His brain weighed 1570 grammes, and Bekhterev observed a large frontal and left parietal lobe, much larger than those of the musicians Borodin and Rubinstein (kept in the Anatomical Museum of the Military Medical Academy in St. Petersburg). However, the size of the left first temporal gyrus (where auditory perception is located) was larger in the musicians' brains than in that of the chemist. A long list of brains were donated to the study. Ivan Turgenev (1808-1883) had a surprisingly heavy brain (2021 grammes), which supported the idea that brain weight and not volume was the cause of prodigious minds (a hypothesis contradicted by the brains of Anatole France and the Soviet leader Lenin). This was such an abundant and novel topic that it led to the creation of a journal incorporating the findings of all these cases (Clinical Archive of Genius and Talent, 1926), which was published for 5 years.

Brains crowded the shelves of laboratory cabinets. The bodies of the founders of Russian neurology, Aleksei Kozhevnikov (1836-1902) and Sergei Korsakov (1854-1900), were soon studied on the autopsy table. Kozhevnikov's brain weighed 1520 grammes and showed a prominent frontal lobe, representing 56.8% of the length of the right hemisphere, and an even larger left frontal lobe (58.3%). Korsakov's brain weighed 1603 grammes, with a great predominance of the left hemisphere, particularly in the frontal and parietal lobes, very similar to that of his master Kozhevnikov.

To organise this line of research, Bekhterev drew up a plan which he explained at the All-Russian Congress of Neurologists and Psychiatry in 1927: the establishment of a large centre in Leningrad (St. Petersburg) which would keep and display the brains of famous personalities (a "pantheon of brains"), but which would also be a laboratory to analyse the keys to the genius in the Bolshevik Soviet Union (Figure 6). All the scientists in the world would turn their heads toward this Bolshevik pantheon of brains, a temple for the worship and study of the brain.

At the age of 72, the Russian academic was requested by Stalin to examine him due to a neurological problem. Bekhterev prescribed him a drug for paranoia. Stalin was enraged, as he considered paranoia to be the worst offence. In fact, with this disease as justification, Stalin, Lavrenti Beria (later killed by Kruschev) and Sergey Kirov (who was found guilty of 1934 murders) were the authors of extensive purges in the Soviet Union. Vladimir

Figure 6. Pantheon of Brains in Moscow

Figure 7. One of the rooms of the Pantheon of Brains.

Bekhterev died 2 days later; his death was officially attributed to an intestinal problem, although many believed that Bekhterev was poisoned on Stalin's orders. His brain was removed (it became the first piece of the collection weighing 1750 grammes), but the rest of the body was not examined and was almost immediately cremated.

On Stalin's orders, the "Pantheon of Brains" project started by Bekhterev was immediately transferred to Moscow, into the directorship of Oskar Vogt, the important German neuropathologist and active Leninist (although always protected by the Krupp family), who studied the "anomalies" of Nazi brains. The Moscow Brain Research Institute became the new "pantheon of brains" and was inaugurated in 1927, three years after Lenin's death. A large brick building from before the revolution was set up to house the Pantheon, which was intended to resemble the Pantheon of Paris. But it was also intended to compete with Parisian neuroanatomy and neurology.

The pantheon stored and displayed as relics hundreds upon hundreds of brains, which should represent a laboratory for research into "patterns of brilliance", and also a mausoleum of the finest Bolshevik minds (Figure 7). The model of studying the brain of the perfect communist activist (rather than race, as was of interest to the Nazis) was acclaimed by the founders of the Soviet Union. Leon Trotsky was the first to speak of the need to create a "communist man", a "superman" who would represent the most developed stage of human evolution.

The Pantheon houses, among many others, the brain of Ivan Pavlov (1849-1936), an important neurophysiologist and the author of the conditioned reflex theory, which he first presented in Madrid in 1903 (International Congress of Medicine). In a statement of his materialist perspective, he even proposed to remove the word "soul" from scientific discourse ("from this point of view, the soul as a naturalistic principle is not at all useful for him [the biologist]. It could be even pernicious for his work, since it pointlessly limits the audacity and depth of his analysis"[11]).

It also contains the brains of Lenin, Stalin, Clara Zetkin (founder of the Social Democratic Party of Germany and International Women's Day), Andrei Bely (Russian novelist), Mayakovsky (the great poet of the Russian Revolution), Grigory Ivanovich Rossolimo (child neuropsychologist, student of Kozhevnikov), Maxim Gorky (Russian revolutionary writer), Konstantin Stanislavski (Russian theatre practitioner and creator of "Stanislavski's system"), Sergei Eisenstein (famous film director of such films as *Battleship Potemkin* and *Ivan the Terrible*), the rocket engineer Konstantin Tsiolkovsky, the secret police founder Vyacheslav Menzhinsky, and high-ranking party officials including Mikhail Kalinin and the fearsome executioner Sergei Kirov. Many of the brains, including Lenin's, were reproduced in plaster, with the originals hidden in a secret place where they could not be accessed.

The collection continued to grow and the final addition to its display cabinets was the brain of the nuclear physician Sakharov (Nobel Peace Prize in 1975); incorporated to the collection in 1989, it weighed 1440 grammes. An attempt was made to remove Tolstoy's brain, however it was rotten.

Currently, after a period of disinterest, the weight of the brain has been discarded as the cause of "intelligence". At the microscopic level, even "neuronal heritage" is not considered the basis for talent and intelligence. Synapses (the changing neuronal connections) have been proposed as an alternative cause.

Lenin's brain

Lenin's was the brain which experienced the most vicissitudes, since it belonged to the most revered revolutionary, and the one that was subject to the greatest efforts to demonstrate the features of genius in its anatomy. Vladimir Ilich Lenin (1870-1924) (Figure 8) was a healthy person, with the exception that he suffered a high frequency of headaches, as did some of his siblings. He lived a healthy life until the age of 51, when he suffered several seizures which made him require a wheelchair. A wide

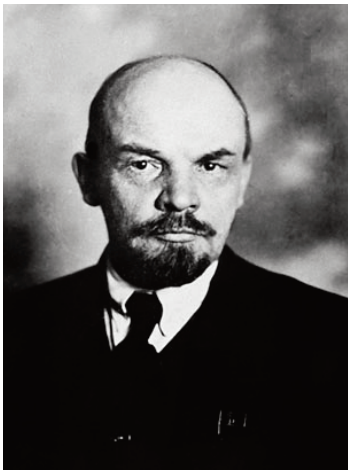

Figure 8. Vladimir Ilich Lenin (1870-1924)

variety of theories emerged after his death, such as syphilis, accidental lead poisoning (he had two bullets in his neck and scapula as the result of an assassination attempt), or criminal cyanide poisoning (ordered by Stalin, of course). In November 1921, he suffered a sudden aphasia during a speech at the 4th Congress of the Communist Party, preventing him from speaking. Strokes recurred and he experienced postictal seizures. He was treated as a syphilis patient, with the administration of arsenic preparations; however, a Wassermann test (for diagnosing syphilis) yielded negative results. Lenin died on 21 January 1924; the autopsy was performed the following day. The brain and heart were removed and frozen, and his body was embalmed as though he were a saint, since the mausoleum under construction inside the Kremlin was to be the "place of pilgrimage of millions of workers".

The brain, after removal, weighed 1340 grammes (much less than his admirers expected). Meninges were thickened and firmly adhered to the inner surface of the skull. The brain, which showed signs of decomposition, had multiple softened areas and a recent haemorrhage in the brainstem (corpora quadrigemina). According to *Izvestia* (meaning "news" in Russian), a newspaper published by the political commissar Semashko, brain cysts (porencephalia?, parasitic?) and an orange colour were observed. The most interesting finding was a generalised arterial pathology, with hardened and narrowed vessels not only in the brain, but also affecting coronary arteries and the aorta. The presence of familial cases, the relatively early onset of the disease, the recurrence, the presence of headaches, and the generalised character of the condition suggested a hereditary disease known as CADASIL (cerebral autosomal dominant arteriopathy with subcortical infarcts and leukoencephalopathy) caused by a mutation of the NOTCH3 gene on the short arm of chromosome 19. Another possibility could be a chronic inflammatory artery disease (tuberculosis, syphilis, cysticercus cyst). The mystery remains unsolved.

The most similar conclusions to ours on cerebral sources of intelligence were those obtained by the German pathologist Oskar Vogt and his wife Cécile Vogt, the French neurologist and student of Pierre Marie (who advised Cécile to think twice before marrying Vogt). It is acknowledged today that Cécile, who was the main author in most of the studies, is due the greatest credit. Even after her husband's death, she travelled to the Balearic Islands in search of insects in order to carry out genetic studies together with her daughter Marguerite.

Oskar Vogt, with the help of the Krupp family, worked at the Kaiser-Wilhelm-Institut für Hirnforschung und allgemeine Biologie in Berlin, and boasted about having located the source of intelligence. He had access to Lenin's brain, which was preserved in formalin for 2 years after his death, and extensively studied it at the Institute in Berlin, particularly focusing on the cortical cells (he made 31 000 slices). Stalin had instructed him: "Find evidence and demonstrate that he was a genius". Vogt stated that he had finally found the "genius cells": his life depended on it. They were actually Betz cells (already mentioned) of an extraordinary size ("giant cells"), a finding which could not be confirmed in subsequent studies. There were definitively no genius cells of any kind. In 1947, Vogt would try to show the criminal character of Nazism through brain anomalies. Finally, Lenin's body was embalmed without his brain, and is kept in the mausoleum in Red Square. The entire propaganda media repeated that Lenin's brain had shrunk due to the excess weight of his revolutionary ideas. Stalin imposed silence on the museum's activities, a rule which was respected by the dictator's successors.

Conclusions

Finally, after a period of decline and abandonment of the pantheon (there was no hot water or heating), attempts have been underway to rehabilitate the

museum since the year 2000. On the second floor of the Institute, Irina Bogolepova was the director of a new museum, the Brain Institute, which aimed to provide a dynamic approach to the knowledge of the nervous system. Its current director, Sergei Illaurushkin (who has no Marxist-Leninist background), has associated the Institute with a large cerebrovascular disease centre with the aim of procuring funds for modernisation. There is no doubt that we are still far from revealing the secrets of the extremely complex machine that is the brain. Many initial steps have been taken, some steady and others stumbling. There will be generations of study before a satisfactory explanation is reached.

Oliver Sacks was tempted to write a history of the museum, but ultimately declined the offer. We should not forget his opinion on the museum:

> It was one of the first neurological research centres to adopt a completely biological approach to human reasoning and intelligence, leaving aside the never-ending list of metaphysical and spiritual explanations governing western neurology in the 20s and 30s.

Centres exist all around the world that house brain collections and museums of a certain size. Examples worthy of mention are those in Paris, Stockholm, Philadelphia, and Tokyo. We should also mention the Wilder Brain Museum, belonging to Cornell University (New York), whose modern, well-equipped building held a collection of 1200 brains in its heyday. The lack of interest in the topic led to the collection being reduced to the 125 pieces which the museum currently possesses. All this suggests that the "myth of the brain", after almost two hundred years, is vanishing.

Conflict of interest

The authors have no conflicts of interest to declare.

References

1. García-Albea E. La neurología en los papiros médicos faraónicos. Rev Neurol. 1999;28:430-3.
2. Broca P. Trépanation chez les incas. Bull Acad Méd (Paris). 1867;32:866-72.
3. Gajdusek DC, Gibbs CJ, Alpers M. Experimental transmission of a kuru-like syndrome to chimpanzees. Nature. 1966;209:794-6.
4. Prusiner SB. Molecular biology of prion diseases. Science. 1991;252:1515-22.
5. Hipócrates. De morbo sacro o el tratado de la epilepsia. Barcelona: Parke Davis; 1999. [Hippocrates. On the sacred disease. In: The Genuine Works of Hippocrates, Vol II, trans. F. Adams. London: Sydenham Society, 1849.]
6. Huarte I. Examen de ingenios para las sciencias. [s.l.]: Oficina Plantiniana; 1603. [Huarte J. The examination of mens wit. trans. Camilli C. and Carew R. London: Richard Watkins, 1954.]
7. Gall FJ. Carta al barón de Retzer. Weimar: Neuer Deutscher Merkur, 1798.
8. García-Albea E. El cerebro de monsieur Leborgne. Summa Neurológica. 2003;2:30-3.
9. Vein AA, Maat-Schieman ML. Famous Russian brains: historical attempts to understand intelligence. Brain. 2008;131:583-90.
10. Zernov DN. On the problem of the anatomical peculiarities of the brain intelligent men. Works of the 2nd Russian Congress of the Physicians. Moscow: M. University; 1887.
11. Pavlov I. Psicología y psicopatología experimentales en los animales. In: Pavlov I. Fisiología y psicología. Madrid; Alianza Editorial, 1970. p.51-90.