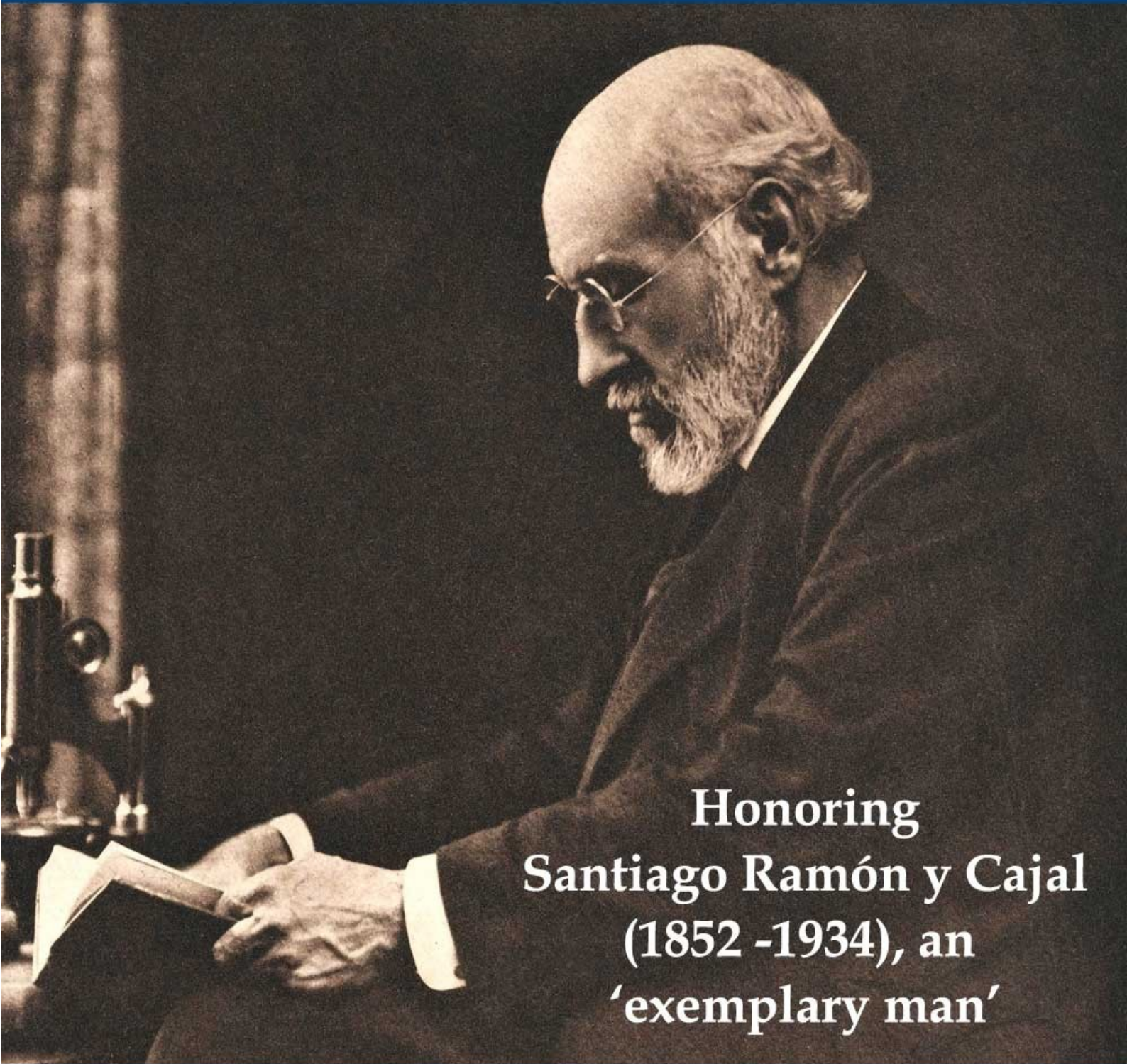


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Santiago Ramón y Cajal
(1852 -1934), an
'exemplary man'

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Madrid, June 2019

Guest Editors: Prof. Dr. María Isabel Porras Gallo

Prof. Dr. María José Báguena

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Reassessing the context of Santiago Ramón y Cajal and his contributions in the 21st century: from the Neuroscience to the literature

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The quality of “exemplary man”, in Max Scheler’s sociological definition of the expression (Scheler, 1981), is one which has been attributed to few scientists throughout history by those who have attempted their biographies: Pedro Laín Entralgo used the term when referring to Ramón y Cajal (Laín Entralgo, 1978). A typical example is Severo Ochoa’s description of Ramón y Cajal as one of the greatest men of science that mankind has ever known: of the stature, in his judgment, of a Galileo, a Newton, a Darwin, a Pasteur or an Einstein, who with their work made possible our current understanding of life, the universe, and nature (Ochoa, 1983).

In this sense, and not wishing to produce a hagiography, Ramón y Cajal can and should be considered a classic (Laín Entralgo, 1978, p. 26). What has enshrined and defined certain texts and authors as classics is the repeated reading of them over time and generations. A classic scientist is one whose work continues to be thought-provoking, valuable and fully contemporary in its fundamental theoretical conceptions. In fact, today, Ramón Cajal is still the most frequently cited scientist, after Einstein (López Piñero, 1988, p. 20). Like Claude Bernard, Louis Pasteur, Charles Darwin, Gregor Mendel and Rudolf Virchow, Santiago Ramón y Cajal established a model of the structure of the nervous system and its functions, the key not only to developing knowledge related to anatomy, physiology and nervous diseases, but

also to the behavioural sciences and the conception of living organisms (López Piñero, 1988, p. 19).

However, it is not possible to fully understand his work, the importance of his neurological school and its subsequent impact, without taking into account Ramón y Cajal’s most distinctive features and the context in which he developed his scientific work. The historian of Medicine, Pedro Laín Entralgo, highlighted Cajal’s propensity for insight, his love of precision and his passion for personal uniqueness as the main personal characteristics that enable us to understand the great work he did.

Taking a quote from Cajal himself in which he confessed his great interest in philosophical reading in his early youth, driven –he said– by his “obsession with reasoning”, Laín related his reading habit not only to intellectual ambition, but also to the hidden wish of the future Nobel Prize-winner to arouse the admiration of his companions. Laín also interprets this “obsession with reasoning”, along with his “literary obsession”, as two key elements that influenced his future scientific career, in that they would have driven him to seek the ultimate basis of what he could see and to interpret what lay before him, taking all imaginable options into account (Laín Entralgo, 1978, p. 22-24). Ramón y Cajal himself established a connection between his interest in philosophical readings and the development of an appropriate attitude for scientific research (Laín Entralgo, 1978, p. 45). Another of Cajal’s traits that Laín highlights, relying heavily on information provided by the man himself, was his great gift for patient contemplation, together with his ability to see and understand the

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results obtained (Laín Entralgo, 1978, p. 25). This same patience was also very useful when producing his drawings. They clearly show the impact, as Cajal confessed, of being “a visual person” and, related to this, the signs of the figurative ability of the painter that he would have become had his father not opposed the pursuit of his early love for painting (Laín Entralgo, 1978, p. 28).

In brief, as Laín Entralgo says,

“Cajal was an eminent man of science, whose genius was characterised by four main features: being able to make visible what could not be seen; being able to see; wanting to understand what he saw according to his own reality; and thereby always to strive to refer ‘what is seen’ to ‘what is’” (Laín Entralgo, 1978, p. 26).

Together with the character of Cajal we have to consider the medium in which his great work was developed. In spite of the lack of resources in Spain, in the mid-19th century practical micrography began to be adopted, in line with the new theories and new technical resources that would reach a greater degree of development in the following decade. Ramón y Cajal came into contact with this milieu and with the proponents of histological studies when he went to Madrid to obtain the title of Doctor. In fact, as reported by the historian of Medicine José María López Piñero, the future academic was impressed by the preparations shown to him by Aureliano Maestre de San Juan and his assistants, and decided to create a micrographic laboratory (López Piñero, 1988, p. 65 -66). Both this initiative and the relationship he began with Aureliano Maestre de San Juan, who held the first official chair of histology (1873), were key to the development of his research. To this we must add the contributions provided by the milieus that Cajal found in Valencia and Barcelona, of which he was also able to take great advantage during his stays in those cities.

When Cajal arrived at the Faculty of Medicine of Valencia, most of his fellow academics followed the new laboratory medicine and based medical science and practice on experimental research. Moreover, as López Piñero indicates, he had the opportunity to join an important scientific institution, the Valencian Medical Institute, which played an essential role in many fields of medicine and provided a favourable environment for experimental work; Ramón y Cajal was also a member of the Editorial Board of the Bulletin of the Valencian Medical Institute during the whole of his stay in the provincial capital (López Piñero, 1988, p. 86-88). Valencia also offered another important advantage at that time, having recovered its important place in the publication of medical books, a situation that must have been helped by the publication of Cajal’s *Manual de Histología* (1884-1888) by the publisher Pascual Aguilar, also responsible for the edition of translations of such outstanding works as *Die Cellularpathologie (...)* (1879) by Rudolf Vir-

chow, *On the Antiseptic Principle of the Practice of Surgery* (1882) by Joseph Lister or *Über die Choleraerabakterien* (1884) by Robert Koch (López Piñero, 1988, p. 88). The *Manual de Histología* was not only the fruit of his continued dedication to histology, but also an example of the scientific enrichment of this future genius, who acknowledged the inclusion of German contributions as well as those of Aureliano Maestre de San Juan and the Parisian school of Ranvier (López Piñero, 1988, p. 103). The year of 1887 provided a new opportunity for scientific enrichment, when he had to be in Madrid to take part in a tribunal for the appointment of a professor. As López Piñero points out, he took advantage of his stay to tour the main micrographic laboratories: his visit to Luis Simarro’s laboratory was a milestone in his decision to devote himself to the histological investigation of the nervous system, after Simarro had shown him the good results provided by silver chromate and had praised the value of Golgi’s book (López Piñero, 1988, p. 104-106).

Cajal’s Barcelona visit also began in a university environment dominated by the ascendancy of the experimentalist philosophy and the existence of a significant scientific institution, the “Academy and Laboratory of Medical Sciences”, as well as of several important journals (Catalan Medical Gazette, Health Gazette of Barcelona and the Journal of Medical Sciences of Barcelona), as mouthpieces for that philosophy, which enabled him to present and publish his new concept of the structure of the nervous system in 1892. During this period, Ramón y Cajal embarked on the considerable task of international dissemination of his new research results (López Piñero, 1988, p. 109-125).

1892 was also the year of his accession to the chair of Histology and Pathological Anatomy of the Faculty of Medicine of Madrid, after the death of Aureliano Maestre de San Juan. There he found an important group of disciples of Laboratory Medicine, as well as a warm reception, thanks to the scientific prestige he had already achieved in specialised media, although his *Texture of the nervous system of man and vertebrates* was yet to be published: it was begun in 1897 and finished in 1904 and was quickly translated into French (*Histologie du système nerveux de l’homme et des vertébrés*, 1909-1911), years after he was awarded the Nobel Prize in Medicine in 1906, shared with Camille Golgi (López Piñero, 1988, p. 137-150).

Undoubtedly, one of Ramón y Cajal’s greatest achievements was the creation of a first-rate neuro-histological school doing acclaimed work, reaching beyond our borders and producing very important results arising from the research work not only of Cajal himself, but also of his disciples (Francisco Tello, Nicolás Achúcarro, Pío del Río-Hortega, Fernando de Castro, Rafael Lorente de Nó, Pedro Ramón y Cajal, Domingo Sánchez and Rodríguez-Lafora, among others) whom he active-

ly encouraged to do quality science. These significant achievements contributed not only to the scientific revival that the regenerationist movement had been longing for in Spain since the 1898 colonial disaster, but were also a key element in the scientific activity of three generations of neuroscientists.

Although this century has already seen numerous studies centred on Ramón y Cajal and his school (Alonso, De Carlos, 2018; Baratas, Fernández, Merino, 2005; Callabed Carracedo, 2019; De Castro, Merchán, 2017; De Felipe, Markram, Wagensberg, 2010; Delgado, Bandrés, 2012; Ehrlich, 2017; Martínez, Sánchez Ron, 2006; Merchán, De Felipe, De Castro, 2016; Muñoz Puelles, 2011; Swanson, Newman, Araque, 2017), the general recognition of such significant major contributions for neuroscience, as well as for other sciences, and their relevance well into the twenty-first century has not yet been sufficiently analysed. The main aim of this special issue is to re-examine the great scientific activity of Santiago Ramón y Cajal in the context of his relationships with two key figures of neurohistology (Kölliker and Golgi) and of the background against which it developed, and to show the present day relevance of its brilliant contributions. It also helps to show how contemporary Spanish society saw his scientific successful activities and the social reactions they provoked, as well as to reveal some scientific and cultural activities of Ramón y Cajal that have so far been little analysed.

The work of Mestres-Ventura, with which the dossier starts, is focused on one of the most important scientific debates in the history of contemporary biology, and offers a perspective with new nuances on the relationships between three of the scientists involved in the approach to the new neuroanatomy as well as scientific hypotheses about the functioning of the nervous system: Kölliker, Ramón y Cajal and Golgi, with particular emphasis on their significance for the promotion and acceptance of the neuron theory in the international scientific community.

Following that, and using a selection of the main Spanish newspapers between 1905 and 1907 to collect news appearing in the press about the awarding of the Nobel Prize in Medicine to Ramón y Cajal in 1906, the article by José Luis Fresquet goes beyond the mere collection and description of texts to delve into what that prize meant for the Spanish society of his time. The variety of ideological tendencies of the news appearing in the newspapers allows the author to reconstruct the different responses given to that honour. The structure of the article into different sections –“The tributes to Echegaray, Manuel García and the anniversary of the creation of *El Quijote*”; “The year of the award of the Nobel Prize” and “The tributes of 1907 and the return to normalcy” –tells us about the social situation and the popular perception of

science and Spanish scientists.

Referring to the Spanish context, specifically to the Regenerationist Movement and the genesis of the Cajal Institute, Angel González de Pablo reconstructs, through the general press, the vicissitudes of the creation of the Biological Research Laboratory in Madrid, predecessor of the Cajal Institute. The analysis of the relationship between the start-up of this research institution and the regenerationist currents is excellent and adds a new perspective of great interest for the knowledge of the history of Spanish science of the first decades of the 20th century.

A different perspective is that of Joaquin Fuster. “From the neuron to the network, from yesterday to today” is an excellent example of the importance of resorting to the history of a concept, idea or process to understand clearly and in depth its current situation and how it has got there. Its structure in three sections– “Cortical organization of Cognits”, “The Perception-Action Cycle” and “Executive Functions of the prefrontal Cortex”– is very useful and leads the reader to an understanding of the changes in scientific knowledge and its successive complexity from Ramón y Cajal until today.

Written in a journalistic style, the paper by Calvo Roy presents a chronological view of the evolution of Ramón y Cajal's publications, scientific and other, in relation to the contexts in which he spent his life. From a linguistic point of view the article includes the controversy of Spanish science (“la polémica de la ciencia española”) and his profile as a scientist and the need to publicise the results of his research. The author uses Ramón y Cajal's own printed publications and the most important bibliography dealing with his figure.

The image, and its potential as an epistemic medium, is a central and current field of research within the so-called “visual epistemology”, or the extent to which pictures are able to communicate knowledge. The main aim of the study by Miguel Angel Rego, using some of Ramón y Cajal's works, emphasises the fact that his artistic skills facilitated the technical transition between notebook and published images, enabling him to formalise his knowledge by including histological results in printed material. One of the positive aspects of the work is the use of a primary source such as the original drawings included in Ramón y Cajal's notebook, *Diario de Observaciones*, and his first published lithographs of cartilage cells and neurons. Furthermore, the work presents an original perspective compared to the approach of many other previous works, cited in the paper, that deal with the engravings and images of the works of Ramón y Cajal with more emphasis on their neuroscientific content. Although the techniques used for drawing are addressed in some of them, the present study does so in a detailed and contextualized manner, pointing out their influences.

Cajal's scientific curiosity and passion for

knowledge is one of the most distinctive features of his personality. Mariano Ayarzagüena explores in his article an aspect that has been less studied: his role in the development of other disciplines that at that time were also included in the field of Natural Sciences, such as Palaeontology, Prehistory and Anthropology; and particularly his work of managing the different institutions that he came to preside, especially after receiving the Nobel Prize for Medicine. Although he excelled in his management work as president of the Junta de Ampliación de Estudios (Board for the Extension of Studies), we must not forget that he was also, among others, president of the Spanish Society of Natural History, director of the Laboratory for Biological Research, and honorary president of the Spanish Society of Anthropology, Ethnography and Prehistory. Ramón y Cajal played an outstanding role in all of them.

The dossier closes with the work of Ryan Davis, from the Department of Languages, Literatures, and Cultures of Illinois State University. As the author says, his paper explores the regenerationist thought of Santiago Ramón y Cajal in his *Vacation Stories* (1905). Due to the allegorical nature of these stories, they constitute a foundational myth on which Ramón y Cajal constructs his vision of a modern Spain. In all the stories reference is made to scientific progress, especially concerning experimental science, and the microscope and bacteriology are always present. They are fictional stories, but with a marked educational character through which he sought to fight against absurd beliefs and superstitions. In the stories difficult social or moral dilemmas are raised, usually motivated by advances in science or by incorrect scientific education of the population. Through these stories, Ramón y Cajal showed his political, religious, moral, educational and scientific ideas.

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Albert von Kölliker, Santiago Ramón y Cajal and Camillo Golgi, the main protagonists in the Neuron Theory debate

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SUMMARY

In the second half of the 19th century Spain was rather isolated from the rest of Europe, although there was remarkable scientific activity. In the midst of this scenario, the figure of Cajal emerged on the scene. During a visit to the laboratory of Luis Simarro in Madrid in 1887, Cajal became acquainted with a paper published by Golgi in 1873 dealing with his famous method. Cajal immediately recognized the value of this method and applied it with much success to the study of the nervous tissue. In the triennium 1887-1889 Cajal's discoveries were so sensational that he decided to attend the meeting of the Anatomische Gesellschaft (Germany Anatomical Society) in Berlin in 1889 in order to present them abroad. The trip proved a great success, and he was able to establish close relations with the president of the society, Alexander von Kölliker, who, in turn, mediated contacts with further renowned scientists such as Retzius, His, Waldeyer, van Gehuchten, etc. Prior to his trip to Berlin, he had already contacted Golgi, but the fact that Cajal's neuronal theory conflicted with Golgi's reticular theory not only prevented a normal relationship between them, but was also—especially on Golgi's part—the source of bitter rivalry between them. Von Kölliker immediately recognized and admired Cajal's stature as a scien-

tist and generously helped him to publicize his ideas throughout the scientific world, and to attain the recognition he deserved. Von Kölliker's relationship with Golgi was of a different nature, and could be described as sincere friendship. Von Kölliker, in fact, proposed both Golgi and Cajal as candidates for the Nobel Prize in 1906, which was subsequently awarded to them jointly. Thanks to Von Kölliker, Cajal's great mentor, the neuronal theory entered the scientific world through the main door and continues to occupy a prevailing position.

Key words: Neuron Theory – Reticular Theory – Golgi method – Von Kölliker – Golgi – Cajal – Retzius

INTRODUCTION

Communication between scientists has always played an essential role in the development and evolution of science. Media have strongly influenced the efficiency of communication, and the nineteenth century witnessed many important changes in this field. The classic media of communication, such as personal contacts, letters and printed books, were complemented in the second half of the nineteenth century by the appearance of numerous periodicals. The foundation of scientific societies opened up new paths for communication, such as organized meetings with lectures, etc., which greatly increased the exchange of information between the participating scientists. Examples in the field of anatomy and physiology were, for example, the Société Anatomique de Paris (Anatomical Society of Paris), founded by Dupuytren and Laennec on 4 December 1803, and also the Anatomische Gesellschaft (German Anatomical Society). The latter was initially a section of

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the Gesellschaft Deutscher Naturforscher und Ärzte (Society of German Naturalists and Physicians, founded on 28 September 1822) and became an independent organization on 23 September 1886. It convened for the first time in Leipzig, where Albert von Kölliker, one of the most relevant figures in the field of anatomy and histology at that time, was elected its first president (Kocsis, 1964; Winkelmann, 2015).

Obviously, language was the key to communication and the most widely used languages in the scientific context were French and German, as well as English. Spanish played no role, a fact which had a very negative effect on scientific activity in Spain in the 19th century. Studies and research carried out in Spain were, of course, published in Spanish, a language with which the scientists in Europe were not familiar. Thus, no relevant scientific contributions were expected to come from Spain.

Cajal had, no doubt, received education in French, as required for the baccalaureate (Law Moyano, 1857). Years later, he additionally acquired a knowledge of German in order to at least be able to read scientific papers in that language (Lopez Piñero, 2014)—a clear indication of the importance Cajal attributed to scientific activities abroad.

However, for many years during and after this period, Cajal did not travel outside of Spain, unlike some of his contemporaries who, for example, visited laboratories in France, Germany, Belgium and Italy, returning with an extensive knowledge of the latest developments in scientific research. In this connection, Cajal manifested his own situation in a letter to Antonio Vicent Dolz (1837-1912), a Jesuit and biologist from Valencia, as well as Cajal's pupil and friend. He visited Germany, France and in Belgium, at the University of Louvain, the laboratory of the famous cytologist Jean Baptiste Carnoy, and published numerous scientific papers, the most prominent of which was a book entitled *Biological Studies* (1892). In this letter, from which the initial part is transcribed, Cajal said:

Valencia, January 1, 1885

My dear Father Vicent:

I was delighted to receive a letter from you, although I never doubted that you would write to me. I can see from your report the satisfaction and pleasure you experienced in your encounter with those wise men. I would like to imitate you, but circumstances preventing this, I have to resign myself to following and observing the scientific developments in Germany and Belgium from afar. (The letter continues with a long description of the scientific work Cajal was engaged in at the time, see Fernandez Santarén, 2014).

The aim of this paper is to re-examine the personal contacts and relationships between Cajal, von Kölliker and Golgi, with a particular emphasis on their significance for the promotion and ac-

ceptance of the neuron theory in the international scientific community.

HOW CAJAL ACQUIRED KNOWLEDGE OF THE LATEST NEUROHISTOLOGICAL METHODS

"Like all important scientists, Cajal suffers on each anniversary under an avalanche of opportunistic publications and picturesque commemorative acts, which are limited to a reiteration of errors and false mythification" (Lopez Piñero, 2014). This author postulates that this state of affairs results from the influence exerted by the so-called "polemic of Spanish science", a controversy in which some praised Spanish scientists and others painted a black picture of it (Lopez Piñero, 2014). Showing a remarkable ignorance of the history of Spanish medicine, Ortega y Gasset came to say of the Spanish scientists of that time: "... they are born without predecessors, by spontaneous generation" (Ortega y Gasset, 1906). On a similar note, Severo Ochoa commented that "..... the way in which Cajal emerged in the scientific wasteland of Spain of his time is a miracle for me" (S. Ochoa, 1995).

By the second half of the nineteenth century, Darwinism, the cell theory and the microscope were already fully in place in Spanish universities, incorporated in study programs and medical education as well as in biomedical research laboratories. Curiously, in addition to the university laboratories, other—perhaps more famous—laboratories were installed by each scientist in his private home and financed by his own means. Courses and seminars in these laboratories were very popular and contributed to their maintenance.

A remarkable number of these scientists were predecessors and contemporaries of Cajal, and some of them were important for Cajal's university career as well as his research (Lopez Piñero, 1999, 2014). In fact, the decision to investigate the nervous system was made by Cajal after a visit to one of these private laboratories. As the medical historian Lopez Piñero has already dealt with this aspect in detail, only a few of Cajal's contemporaries will be mentioned here: Aureliano Maestre de San Juan guided him during his preparations for the appointment procedures for a university chair; Leopoldo López García, who was an excellent teacher and researcher and who had worked with Ranvier in Paris and, finally, the most relevant in the present context: Luis Simarro Lacabra (Rodriguez Lafora, 1921; Lopez Piñero, 1999).

In 1884, Cajal was awarded a chair at the University of Valencia, an environment characterized by very modern ideas in science. Cajal's initial research in Valencia was dedicated to the investigation of the structure of the epithelium and the striated muscle of insects (López Piñero, 2014). He also continued the bacteriological studies, which he had begun in Zaragoza (López Piñero,

2014). At that time, nervous tissue was not a topic that merited much attention, probably due to the lack of efficient techniques with which to demonstrate nerve cells and other details of neural tissue. However, this situation was about to change.

In 1887, during a stay in Madrid, Cajal visited Simarro's laboratory. Simarro had spent five years (1880-1885) in Paris working with Duval, Ranvier, Charcot and Magnan. It was Ranvier's influence that led Simarro to focus his research on neurohistology. During Cajal's visit, Simarro showed him some beautiful preparations stained according to the Golgi method (Golgi, 1873). Cajal was highly impressed and immediately saw the value of this technique for the investigation of nervous tissue. On this visit, Simarro showed Cajal another technical innovation from Germany: Weigert and Pal's method of staining myelin, indisputably an excellent tool in neurohistology and neuroanatomy. Later on, Simarro explained to Cajal his own technique for staining nerve cells, the "photographic method", on the basis of which, Cajal, many years later, developed his reduced silver nitrate method. The above serves to establish that, at Cajal's time, there existed a well-informed group of scientists—Simarro was not the only one—with extensive activities in their own laboratories and with good contacts abroad.

THE FRUITFUL YEARS IN VALENCIA AND BARCELONA

Cajal's visit to Simarro's laboratory had a great impact on him and he thereafter began to work intensively with the Golgi method, discovering very successful technical variations, which increased its reliability. The most relevant in this respect, whereby good results were consistently achieved, were: a) double impregnation and b) the application of the technique to the nervous tissue of young animals and those in varying phases of development, whereby His and Forel were probably the source of inspiration here.

With this technical background, he was awarded a chair at the University of Barcelona in 1888, where he investigated almost all the regions of the nervous system, in particular the cerebellum, retina and the spinal cord. In just three years, the discoveries made allowed Cajal to formulate a theory on the individuality of nerve cells and the organization of the nervous system in circuits, with functional implications never hitherto contemplated. This neuronal doctrine theory formulated by Cajal conflicted with Gerlach's reticular theory (1872), a theory which Golgi supported.

CAJAL'S FIRST ENCOUNTER WITH VON KÖLLIKER AND THEIR LATER RELATIONSHIP

Cajal considered his data to be of sufficient importance and decided to attend the annual con-

gress of the Anatomische Gesellschaft (German Anatomical Society) in Berlin in 1889, at that time the most highly regarded professional society in Europe (Fig. 1). Cajal was 37 years old.

In his memoirs Cajal (1923) recalled his first encounter with von Kölliker (Fig. 2) at this meeting in Berlin as follows:

I installed myself very early in the ad hoc laboratory room, where on large tables and in front of large windows, numerous microscopes shone. I unpacked my preparations; requiring two or three amplifying instruments, in addition to the excellent Zeiss model, brought as a precaution. I set the focus on the most expressive sections with cerebellum, retina and spinal cord structures and, in short, began to explain to those interested in bad French the contents of my preparations and a few histologists surrounded me. Only a few as, as at such events, every congress participant pursues his own interests and they were more skeptical than interested. No doubt they expected a fiasco. But, after having inspected the contents of the preparations, the puckered frowns had disappeared. Finally, all reserve towards the modest Spanish anatomy faded and warm and sincere congratulations were forthcoming. The most interested of my listeners was A. Von Kölliker, the venerable patriarch of German Histology. At the end of the session he drove me in a carriage to the luxurious hotel in which he was staying; he invited me to a meal and presented me to the most outstanding histologists and embryologists in Germany and, finally, he went out of his way to make my stay in the Prussian capital as pleasant as possible (Ramón y Cajal, 1923).

Some authors are rather skeptical of Cajal's version of the great enthusiasm with which his preparations were received by such famous anatomists as von Kölliker, His and others (Jacobson, 1995; Fishman, 2007). They argue that none of this great enthusiasm is mentioned by von Kölliker in his autobiography (Liddel, 1960). Jacobson (1995, page 248) notes that von Kölliker only describes the social event in his autobiography, but does not mention the significance of the scientific demonstration. However, the corresponding passage in von Kölliker's memoirs (1899, see pages 233-234) does not explain the reason for these controversial interpretations:

Later in the course of these investigations, a new, vigorous and distinguished champion soon appeared, D. Santiago Ramón y Cajal, who took part in the Berlin International Medical Congress in 1889 and presented a series of such excellent preparations, especially on the spinal cord that it seemed to me an important task to acquaint the Spanish erudite, who was not strong in German, with our anatomists, of whom I mention by name His, Flechsig, Waldeyer, and Schwalbe.

Since then, all of us who are occupied with the fine structures of the nervous system, especially,

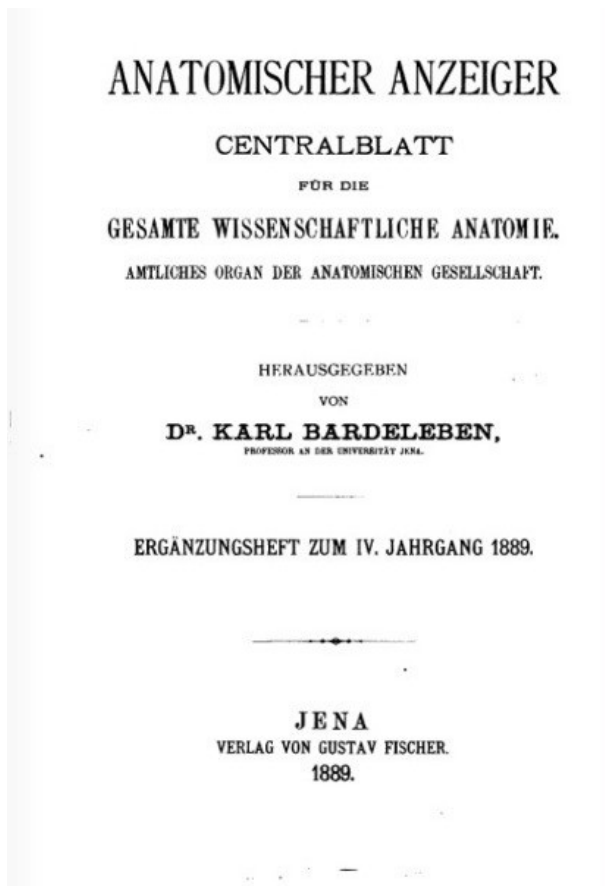


Fig 1.- Cover page of the proceedings of the annual meeting of the Anatomische Gesellschaft celebrated in Berlin 1889, in which Cajal participated.

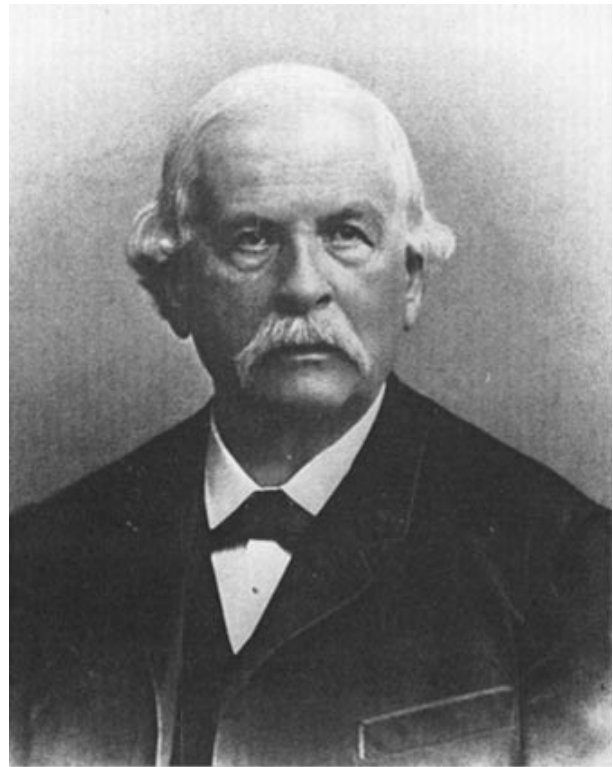
apart from myself, G. Retzius, v. Lenhossék and v. Gehuchten, base their work on Golgi's and Ramón's models.

In this text, von Kölliker expressed his pleasant surprise and admiration of the personality and courage of the young Spanish scientist, and expressly mentioned the preparations, in particular those of the spinal cord. This was a subject von Kölliker was very knowledgeable in, as he had worked on it, even using the Golgi technique, prior to his encounter with Cajal.

One must bear in mind that Cajal was very young (Fig. 3) on this first trip abroad, and the great attention he unexpectedly received from so many illustrious scientists attending the congress would have been a great boost to his ego. This would explain his description of these events in his memoirs 44 years later, not necessarily rendering it inaccurate.

In 1913, Arthur van Gehuchten (Fig. 4) delivered a speech at a ceremony in honor of his 25 years of office at the University of Louvain. He referred in this speech to the encounter between von Kölliker and Cajal, which van Gehuchten personally witnessed as a participant at the conference in Berlin. The speech reads as follows:

The facts described by Cajal in his first publications were so strange that the histologists of that



A. Kölliker.

Fig 2.- Albert von Kölliker, professor of anatomy, director of the Institute of Anatomy and Physiology in Würzburg and president of the Anatomische Gesellschaft.

time— we did not belong happily to this group— accepted them with the greatest skepticism. The distrust was such that, at the Congress of Anatomists held in Berlin in 1889, Cajal, who later became the great histologist of Madrid, found himself alone, raising around him only incredulous smiles. I still see him taking Von Kölliker aside, the then undisputed master of German histology, and drag him to a corner of the demonstration room, to show him under the microscope his admirable preparations and convince him at the same time of the reality of the facts that he claimed to have discovered. The demonstration was so impressive that, a few months later the histologist of Würzburg confirmed all the facts asserted by Cajal.

Van Gehuchten's observation largely confirmed Cajal's version in his memoirs (Cajal, 1923) and von Kölliker's text does not exactly contradict what Cajal said either (von Kölliker, 1899).

Von Kölliker had a generous and respectful attitude to Cajal, always willing to help him in any way he could. In his memoirs Cajal recognized this and said literally:

"I am very grateful to the distinguished master of Würzburg". No doubt the truth would have found a way in the end. But von Kölliker's great authority helped to spread my ideas quickly and ensured their appreciation by the scientific world." It can be



S. Ramon y Cajal

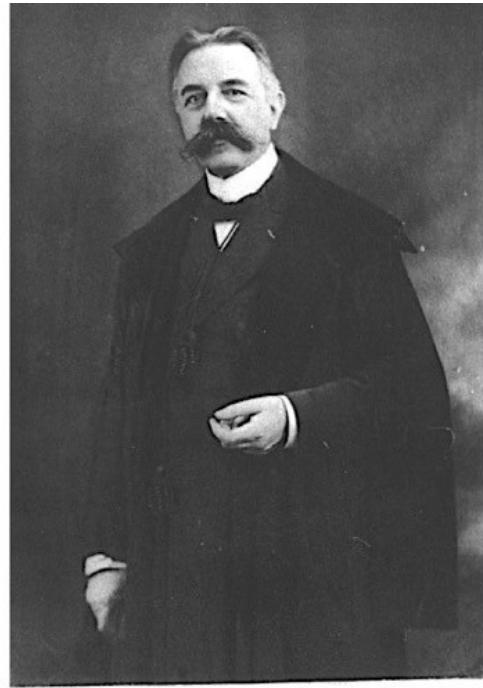
Fig 3.- Santiago Ramón y Cajal, professor of anatomy and histology at the University of Madrid.

maintained that, after Berlin, Cajal was no longer a simple, anonymous foot soldier in the world of science.

Among the correspondence between von Kölliker and Cajal are two letters and a postcard. The first letter is dated 29 May 1892, and it is handwritten in French. The postcard is written in French, and it is dated 8 August 1893. The second letter, also handwritten in French, bears the date 21 December 1893 (Cajal Institute Archive Inventory number 11329, 7404 and 7005 respectively). This is not much, but it does serve to document the kind of relationship that existed between the two.

In the letter of 29 May 1892, von Kölliker offered to translate Cajal's paper on the Ammon's horn from Spanish into German, and then publish it in the *Zeitschrift für wissenschaftliche Zoologie* (Scientific Journal of Zoology).

In the letter dated 8 August 1893, he also thanked Cajal for sending him the monograph *La rétine des Vertébrés* (1892), and respectfully asked if he could send him preparations, promising to return them. He further informed Cajal that he had sent the print proofs of the paper on the Ammon's horn (which he had translated into German). Von Kölliker's letters are respectable and amiable in tone, but nothing more. In spite of everything that has been said, their relationship never



Arthur van Gehuchten

Fig 4.- Arthur van Gehuchten, professor of anatomy at the University of Louvain (Belgium).

became as friendly as that between von Kölliker and Golgi, with close private contact and reciprocal visits.

The results, which Cajal obtained with his own modifications of the Golgi method, were so impressive that Von Kölliker started a series of studies to confirm them. At the advanced age of 70, he learned Spanish in order to be able to read the original papers and, as already mentioned, he translated some of them into German for publication in the journal, of which he was editor. But despite all this appreciation, he maintained a certain critical distance from Cajal, as evidenced by a letter to Golgi (letter no. 37, 24 February 1901, see in Belloni, 1975), in which he ironically commented that Cajal believed to be one of the supreme histologists, and the only one entitled to have an opinion about the nervous system (also mentioned by Hildebrand, 1989). A further critical point was when Cajal published his comments on the studies of two of Golgi's pupils, Veratti and Vincenzi, in *Textura del Sistema Nervioso del Hombre y de los Vertebrados* (Histology of the Nervous System of Man and Vertebrates) [(1904) page 146 volume 2/1: "*Por cierto que las conclusiones a que estos dos últimos sabios [Veratti y Vincenzi] han llegado en sus recientes estudios sobre el argumento, son tan extrañas e inesperadas, que pueden consider-*

arse como los más elocuentes ejemplos de los desgraciados errores de interpretación en que pueden caer observadores de talento, cuando imbuidos en un prejuicio erróneo, trabajan non en favor de la verdad, sino en defensa de una determinada escuela" (see also Belloni, 1975 page 211)]. A second controversial matter was the list of papers Cajal published in 1900, most likely in the forefront of the Nobel Prize (Ramón y Cajal, 1900). Von Kölliker considered both actions to be inappropriate (in the original text: "dass es nicht erlaubt ist, sich in derartigem Stil hervorzutun"), meaning that this manner of self-portrayal is not decorous. He was particularly disappointed at the way in which Cajal had criticized the pupils of his friend Golgi. However, it is quite possible that Cajal had no knowledge of the discontent he had caused, as it was only expressed in the private correspondence between von Kölliker and Golgi.

Nevertheless, von Kölliker's mediation had not only ensured the rapid dissemination and acceptance of Cajal's ideas in the scientific world (Cajal, 1923; Tello, 1935), but had also influenced the generosity with which the German scientific world treated Cajal. In 1895, he was elected corresponding member of the Physikalisch-Medizinische Gesellschaft (Physics and Medical Society), founded by von Kölliker in Würzburg (Bergua and Kreuzer, 1997). In 1896 the University of Würzburg awarded him the title of Doctor honoris causa (Bergua and Kreuzer, 1997). Through the intervention of Rudolf Virchow, Cajal became a member of the Real Academia de Ciencias (Royal Academy of Exact, Physical and Natural Sciences) in Madrid in 1897 (Bergua and Kreuzer, 1997). In early 1905, one year before Cajal was awarded the Nobel Prize, he received the Helmholtz-Medaille der Berlin-Brandenburgischen Akademie der Wissenschaften (Helmholtz Gold Medal of the Imperial Academy of Science of Berlin), one of the awards most appreciated by Cajal (Ramón y Cajal, 1923).

VON KÖLLIKER AND GOLGI

Von Kölliker and Golgi (Fig. 5) had contact for the first time in 1887, and except for a small initial misunderstanding, a sincere and deep friendship developed between them, which lasted for almost twenty years, up to the death of Von Kölliker in 1905 (Belloni, 1975).

In 1887, von Kölliker was an exceptionally vigorous and lucid seventy-year-old man, who had first-hand experience of the evolution of histology in the second half of the nineteenth century (Belloni, 1975). At that time, Golgi was forty-four years old and a national celebrity, but he had not yet achieved international fame (Belloni, 1975).

In February 1872, Golgi moved to Abbiategrasso and remained there until December 1875, when he returned to Pavia as an extraordinary professor of

Histology (Jaffé Ribbi, 2013). During this time the greatest event of his scientific life had occurred: the discovery of the "black reaction", which opened a new epoch in the microscopy of the nervous system. It took a long time for this discovery to become internationally known, as Golgi had published it in a magazine that had no circulation outside Italy (Golgi, 1873).

The "Golgi method" first attracted attention outside Italy at a conference of the Gesellschaft der Ärzte (Association of Physicians), which took place in Zürich on December 5, 1885; Eugen Bleuler exhibited some preparations of rabbit cerebral cortex stained according to this method. Paul Eugen Bleuler (1859-1939) was a psychiatrist who created the term schizophrenia. However, von Kölliker's international promotion of the Golgi method was much more effective than Bleuler's contribution.

Immediately after the first contact, von Kölliker and Golgi exchanged an abundance of correspondence, 53 letters of which are inventoried in the History Museum of the University of Pavia (Belloni, 1975). These letters are valuable documents, giving us an idea of the close relationship, which existed between these two remarkable scientists. As already mentioned, von Kölliker and Golgi had already met before von Kölliker encountered Cajal in 1889 and he had already carried out experiments with the Golgi method before he became acquainted with Cajal.

From the first letter it can be deduced that Golgi had sent some preparations, which he had stained according to his method to von Kölliker. The latter was very impressed by them and expressed his appreciation of the gesture (letter no. 1 of 3 May 1887, Belloni, 1975). Three weeks later von Kölliker wrote again to thank Golgi for lending him the preparations and to tell him that they had been presented to the Physikalisch-Medizinische Gesellschaft in Würzburg (Würzburg Physics and Medical Society), where they had been received with great enthusiasm (letter no. 2, 22 May 1887, see Belloni, 1975). Von Kölliker did add that he did not agree fully with Golgi's reticularistic conclusions, but he took care not to upset Golgi with this differing opinion.

Von Kölliker was disturbed by the fact that Golgi did not reply to this letter (letter no. 3, 14 April 1889), and, in order to clarify the situation, he wrote to Giulio Bizzozero, an Italian pathologist and histologist. The latter was not only head of the laboratory where Golgi worked but also the uncle of Golgi's wife, Lina Aletti. In his letter (no. 3 bis dated 23 March 1890) von Kölliker wrote:

"Maintenant un travail sorti de son laboratoire dans l'internationale Monatsschrift" m'a fait venir l'idée que Golgi, que je croyais un ami et du quel j'ai le plus grand respect comme homme de science pourrait m'avoir pris en mal, que je ne puis accepter toutes les conclusions, aux quelles il arrive"



Camillo Golgi

Fig 5.- Camillo Golgi, professor and Rector of the University of Pavia.

On April 12 1890, von Kölliker wrote to Golgi (letter no. 4), thanking him for a letter, which Golgi had probably written as a reaction to the letter that von Kölliker had sent to Bizzozero. In this letter, von Kölliker stressed that his disagreement with Golgi over scientific issues was not due to any lack of appreciation on his part. This is further evidence of the importance to him of his personal relationship with Golgi, whom he regarded as a true friend. Apparently Golgi's wife, Lina Aletti, also tried to mitigate the situation. This can be deduced from the existence of a letter, which von Kölliker sent to Mrs. Golgi (letter no. 4bis, von Kölliker to Mrs. Golgi, Belloni, 1975).

In December 1893 von Kölliker informed Golgi of the Rinecker award. The letter begins as follows (letter no. 12, Belloni, 1975):

Wurzburg le 8 Dec 93.

Mon cher ami! Je viens vous annoncer, que notre Faculté de Médecine a décrété par unanimité de vous donner le Prix Rinecker, qui se donne tous les trois ans pour travaux les plus remarquables dans une des branches de la médecine.

Presumably in order to stress the importance of the prize, von Kölliker mentions in this letter that this award was granted to Robert Koch in 1891 and concludes the letter by expressing his satisfaction at being the first to announce the good

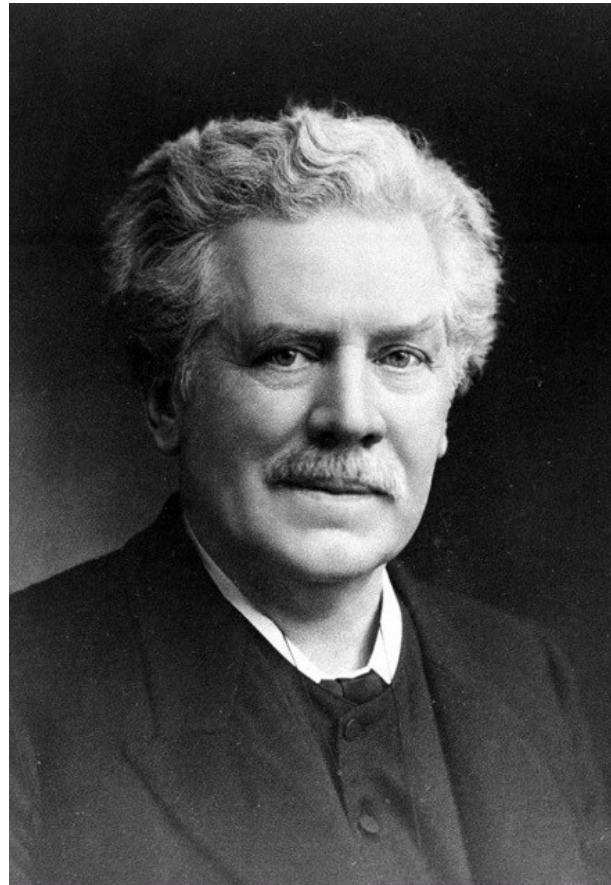


Fig 6.- Magnus Gustaf Retzius, professor of anatomy at the Karolinska-Institute in Stockholm.

news. It is very unlikely that this prize would have been awarded to Golgi without von Kölliker's intervention; a further act of friendship. From thereon, the correspondence between them reveals close mutual ties, which extended to the families. There were several meetings in Italy and abroad, at which their wives were also present and both academic and family events, such as Golgi's silver wedding, were celebrated together.

Several of von Kölliker's letters to Golgi stressed the importance of the publication of his discoveries in journals outside of Italy (see L'Epistolario, by Belloni, 1975) and he offered his support in this undertaking.

In their later letters von Kölliker and Golgi also discussed the Nobel Prize. Von Kölliker was deeply involved in and intent on qualifying neurohistological research for the award; he considered the "reazione nera" to be the most important development in histological techniques of the whole era. Von Kölliker proposed Golgi for the Nobel Prize in 1901, but, being unsuccessful, he recommended to wait until Golgi's Opera Omnia was published, which happened in 1903. Von Kölliker proposed Golgi and Cajal jointly for the award in 1905 and 1906. Von Kölliker died in 1905; he submitted his proposal one year before the award was granted (see for nominations: <https://www.nobelprize.org/>)

nobel_prizes/medicine/laureates/).

CAJAL AND GOLGI

Cajal contacted Golgi for the first time in 1888, when he sent him a letter together with recent papers published in the *Revista Trimestral de Histología* (Quarterly Journal of Histology), which he had founded in Barcelona.

In these early papers Cajal proved the individuality of the neurons in the retina, olfactory bulb and spinal cord using the Golgi method and modifications of the same, which he had developed.

Two letters from Cajal to Golgi still exist. In the first one of 22 May 1888 Cajal wrote to Golgi:

My respectable colleague:

I send you my new work published in the Revista Trimestral de Histología (Quarterly Journal of Histology). Here you will find some discoveries, which were achieved using your admirable method.

I have also sent my journal to Mr. Petrone and to Fusari and Magini. As I do not have their addresses, I would be grateful if you could send me the addresses of Mr. Maggini and Mr. Petrones.

In highest esteem,

Signed: S. Ramón y Cajal

Golgi ignored Cajal's work and, according to Fernández Santarén (2014), he was even quite offended that an unknown Spanish scientist should attack his reticular theory. The second letter of 27 August 1889 is a document of great value, as it reveals Cajal's intention to visit the wise man of Pavia. The text of this letter (original in French) is as follows:

Sir and dear colleague:

*I am currently studying the structure of the olfactory bulb, a subject that I consider extremely important in order to establish the mode of connection between the sensory fibers and the bulbous cells of the centers. As I have read many authors' contributions on this topic, I am aware of your opinion. However, I would like to consult your memory: I would appreciate it if you could send me a copy of *Sulla fina struttura del bulbi offatori 1875* if you still have any or if you could tell me which publisher could provide it. I also wish to thank you for sending me your latest research report on malaria. One of my pupils is researching this subject and has confirmed a large part of your conclusions.*

I plan to go to Berlin next October. My discoveries with regard to the embryonic medulla, which you will have seen in my Journal, are so astounding that I feel it imperative to exhibit my preparations prior to translating the discoveries into French. Fortunately, my preparations are so convincing and conclusive that the facts cannot be denied.

On my return from Berlin I intend to visit you in Pavia and show you the preparations made with your admirable method. I would also like to exam-

ine yours and listen to your wise advice.

Accept Sir and dear colleague the expression of my highest esteem

Signed in Barcelona: S. Ramón y Cajal

Both letters were very polite in tone and impeccable in style, which makes the lack of response to them surprising, especially in view of the fact that Golgi had previously written to Cajal and sent him his paper on malaria (see 2nd letter, Fernández Santarén, 2014).

Cajal nevertheless visited him in Pavia, but it would seem that Golgi did not want to receive him or, as Cajal says in his memoirs, he "was apparently absent", which sounds more like a feigned absence (Fernández Santarén, 2014).

Golgi was well informed of the events at the congress in October 1889 in Berlin, and was therefore aware of what Cajal and his ideas represented for his reticular theory. The controversy acquired a greater dimension in 1890, when Cajal published in the *Anatomischer Anzeiger* (now *Annals of Anatomy*) a paper on the origin and ramifications of nerve fibers in the embryonic spinal cord. Cajal claimed the discovery of the collaterals of the axons of the spinal cord for himself, without any mention of Golgi, who had already described them ten years previously. It is only fair to mention that Cajal had published these findings in Spanish in the *Quarterly Journal* one year previously and had also sent this publication to Golgi. Golgi did not raise the question of precedence, as he was probably occupied with other scientific issues (at that time he was researching malaria), but it is also possible that he had not read Cajal's letter or papers. Here a Spanish proverb seems appropriate: the greatest form of disdain is lack of appreciation.

The rivalry was bitter and Golgi did not miss any opportunity to attack Cajal's theory of connections and dynamic polarization (Fernández Santarén, 2014).

All this was just the prolegomena of a drama which reached a climax years later at the Nobel Prize award ceremony in Stockholm in 1906, an event which Cajal described in his memoirs as having been embarrassing in many respects (Ramón y Cajal, 1923, chapter 22, pages 355 and following).

Unfortunately, a friendly or collegial relationship never existed between them, despite Cajal's well-intentioned approaches.

FINAL CONSIDERATIONS

The three main figures in this story are outstanding in many respects. Von Kölliker, at the time of his acquaintance with Cajal and Golgi, enjoyed great influence and possessed extensive experience in science and university affairs. His main contribution was to have recognized that Golgi and Cajal were geniuses capable of revolutionizing the histology of the nervous system, while, at the

same time, not allowing his personal preferences (his friendship with Golgi) to affect his judgment on the value of Cajal's and Golgi's scientific contributions.

Cajal was the youngest of the three, and he was treated as an outsider on the international scientific stage, among other reasons due to his strong personality. He has often been described as friendly but with an outstanding character, a description that offers room for varying interpretations (Lorusso, 2013; Jacobson, 1995; Fishman, 2007). Cajal's abundant correspondence, inventoried in various archives, also reveals a great deal about the type of person that he was (López Piñero, 2014; Fernandez Santarén, 2014).

Golgi was reported as being privately introverted, quiet and reserved, while his manner in public has often been described as severe and even authoritarian (Lorusso, 2013). Maybe the latter facets shed some light on his attitude towards Cajal.

In the period of nominations for the Nobel Prize until 1906, the behavior of these three protagonists was somewhat unusual. Von Kölliker proposed Golgi for the Nobel Prize in 1901, although he was aware of the fact that Cajal had made considerable improvements on the Golgi method. He was, furthermore, of the opinion that Cajal was right with his neuronal theory and had evidently come to reject Golgi's reticular theory. One wonders: why did he act in this way?

In this connection another wise man, Magnus Gustaf Retzius, must be mentioned, who intervened very actively in the Nobel Prize affairs (Fig. 6). This Swedish scientist, who was member of the prize award committee, maintained a close relationship with von Kölliker over the years, frequently exchanging opinions about potential candidates for the award. Unlike von Kölliker, Retzius proposed Cajal from the beginning and every year until 1906.

He confessed in his biography that he had reached the conclusion that Cajal was the only one who really deserved the award, as he had not only brilliantly described the structural intricacies of the nervous tissue, but had also been able to create an understandable theory about it, the validity of which is even today indisputable (Retzius, 1948; Grant, 2007). Against the background of their close contact, one wonders if Retzius may have influenced von Kölliker on the question of nominations for the Nobel Prize.

The interrelations between von Kölliker, Cajal and Golgi are an example of the era when scientists were called wise, where science did not have a common language, where competitiveness in the laboratory and the struggle for scientific primacy was not at odds with generosity, respect and friendship (Alonso, 2014), but, as has been shown here, there were also cases which were accompanied by the most acerbic rivalry.

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The image of Santiago Ramón y Cajal through the daily press.

The awarding of the Nobel Prize

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SUMMARY

The purpose of this essay is to approach the figure of Cajal from a different perspective. It seeks to study the image of the Spanish scientist through the non-professional daily press and, in particular, the impact made by his Nobel Prize in Physiology and Medicine in 1906. The importance of the press as a historical source today is unquestionable. In this case, it can largely be useful for providing public opinion about Cajal and allowing us to get close to the historical context and the ideological material of press, news, and articles. Major publications of the time from the main cities of Spain have been selected, such as *El Imparcial*, *El Liberal*, the *Heraldo de Madrid*, *El País*, *La Vanguardia y Las Provincias*, as well as the magazines *Nuevo Mundo*, *Madrid científico*, *Mundo científico*, *La Ilustración española y americana*, *La Educación*, and *La Escuela moderna* through 1906, the year before (1905) and the year after (1907).

Key words: History of Medicine – Journalism – Santiago Ramón y Cajal – 1905-1907

INTRODUCTION

As Cajal points out in *Historia de mi labor científica* (1917), in the two years 1905-1906 when he obtained the Helmholtz gold medal and the Nobel Prize, he received “congratulations and awards galore”, he suffered the disadvantages of becom-

ing famous and he refused a ministerial portfolio. This paper attempts to respond to the questions of how Spanish society saw all these events through the press. What image of Cajal did newspapers and magazines transmit?

A wide range of non-professional periodicals has been used for this purpose. All of them are from Madrid except for *La Vanguardia*, from Barcelona, and *Las Provincias*, from Valencia. We have chosen several newspapers from the capital of the country such as *El País*, Republican-leaning and in which many of the members of the Generation of '98 and the journalistic and literary “Bohemians” wrote; *El Imparcial*, a modern democratic newspaper and probably the most influential at the end of the nineteenth century and the first years of the twentieth; the evening paper *El Heraldo de Madrid*, one of the best-selling and most popular, with broad acceptance by the working class; and the morning paper *El Liberal*, of moderate liberal Republican tendencies. Some magazines have also been selected, such as *La Ilustración española y americana*, the greatest exponent of Spanish graphic journalism of the nineteenth century; *Nuevo Mundo*, a kind of news magazine that replaced the printed images of the previous one with new resources such as graphic reports and photography; *La Educación*, a professional newspaper devoted to teaching at all levels; *La Escuela moderna*, which was devoted to teacher training, women’s education and dissemination of pedagogical knowledge; *Madrid científico*, a scientific-technical newspaper focused mainly on engineers and written mostly by them, through a wide range of subjects and disciplines; and *Mundo científico*, subtitled “a newspaper that summarises scientific advances and useful knowledge applied to arts, industry and agriculture”. As has been stated, *La Vanguardia* has been also consulted, a general

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morning newspaper edited in Barcelona for distribution throughout Spain, with excellent editors and the first Spanish newspaper to have correspondents in Paris and Berlin; as well as *Las Provincias*, edited in Valencia and of a regionalist, conservative and of moderate reforming tendencies.

From all of them we have selected news items, articles, and reports from 1905, 1906 and 1907 that include the name of Ramón y Cajal. As shown in Table 1, 654 references were collected, from which 28.79% (188) appeared in 1905, 40.58% (265) in 1906, and 30.62% (200) in 1907. The newspaper from the sample chosen that published the most news containing the name of Cajal was *El País*, not only in 1905 but also in 1906 and 1907 (131), followed by *El Imparcial* and the Valencian *Las Provincias* (both with 100), *La Vanguardia* (94), *El Heraldo de Madrid* (93), and *El Liberal* (85). The magazines are far behind, as can be seen in Table 1.

It would be possible to establish three categories according to the weight of the name of Cajal found in the news. First, the category in which he is the main protagonist; second, that related to activities carried out unconnected with his work; and third, the category in which he is mentioned in passing on various subjects. In 1905, the most noteworthy news and articles were of types 1 and 3; in 1906 clearly of type 1; and in 1907 of type 1, almost equally followed by the other two categories. This means that the name of Cajal was included in many news and articles as a highly popular person, with a prestigious career as a man of science. In some cases, he appears along with other prominent names such as José Echegaray, Torres Quevedo, Menéndez Pelayo, Julián Calleja, Benito Pérez Galdós, Amalio Gimeno, Giner de los Ríos, etc. At other times his name is linked to the activities in which he participates, such as lectures, trib-

utes, anniversaries, or as a member of commissions and committees, generally concerning medicine and science. Finally, for the most part, his name appears related to information about his research and professional activity.

Once the contents of materials from this period have been analysed, there are some important milestones where the name of Cajal appears. In chronological order, the most outstanding landmarks are his participation at the homage to José Echegaray for the Nobel Prize (1905); the award of the Helmholtz Prize (1905); the celebration of the anniversary of Manuel García and the anniversary of the publication of *Don Quixote* (1905); his election as a member of the Spanish Royal Academy (1905); the offer and rejection of a ministerial portfolio (1906); the award of the Nobel Prize for Medicine and Physiology (1906); and his admission to the Royal Academy of Medicine (1907).

TRIBUTES TO ECHEGARAY AND MANUEL GARCÍA AND THE ANNIVERSARY OF THE PUBLICATION OF DON QUIXOTE

The year 1905 begins with an interview with Cajal in *El Heraldo de Madrid* about his opinion of clinical education in Spain. This was a subject of great interest for the newspapers at the time, and this paper put it on the front page. It was intended to obtain the opinion of several professors on the vox populi criticism, especially after the Valencian Francisco Moliner condemned the poor quality of medical education in Spain in his opening speech of the academic year. In the interview, Cajal stated that it was not so bad and that much progress had been made in “the last few years”. This refers to the consultation the Ministry had had with him some time before, and Cajal’s recommendation to provide teachers with hospital work placements to

Newspaper/Magazine	Year 1905	Year 1906	Year 1907	Total
<i>El País</i>	36	51	44	131
<i>El Imparcial</i>	35	34	31	100
<i>Las Provincias</i>	19	51	30	100
<i>La Vanguardia</i>	24	39	31	94
<i>Heraldo de Madrid</i>	22	41	30	93
<i>El Liberal</i>	29	34	22	85
<i>La Educación</i>	8	6	0	14
<i>Nuevo Mundo</i>	8	0	4	12
<i>Madrid científico</i>	2	2	4	8
<i>La Escuela Moderna</i>	2	1	3	6
<i>La Ilustración Española y Americana</i>	2	2	1	5
<i>Mundo científico</i>	1	4	0	5
Total	188	265	200	653

Table 1. Number of news items, articles and pieces of information which contain the name of Santiago Ramón y Cajal in a selection of non-professional newspapers and magazines between 1905 and 1907.

reinforce work practice, as other countries did (Montemar, 1905). However, he was not in favour of turning all doctors who practised at hospitals into teachers. This type of news including the opinion of the histologist on subjects more or less related to medicine was quite common.

Apart from appearing in other news of minor importance, Cajal's name appears in connection with the homage to José Echegaray in 1905 for his Nobel Prize in Literature. He was the first Spaniard to receive it. This tribute took place in different settings of the capital, three of the most notable being the National Library, the Senate and the Athenaeum of Madrid, as well as the large popular demonstration from the Plaza de Oriente to the Paseo de Recoletos. Some writers, nevertheless, among them the young authors of the Generation of '98, declared that although they felt respect for the person, their aesthetic ideas and admiration were very different. The most critical were Azorín and Valle Inclán, who thought that he was a representative of a Spain that was "old-fashioned, dead, corroded by prejudices and superstition, assaulted by caciques, and exploited by a venal bureaucracy..."

The public was with the playwright. Any Spaniard receiving an award abroad deserved the respect and applause of the ordinary citizens. The tribute was a success. Thousands of people marched past the prize-winner in front of the steps of the National Library, and Canalejas made an eloquent speech which was answered by the protagonist of the event.

At the reception that was held in the Ateneo, Spanish intellectuals of the day paid tribute to him with several speeches: Serafín Álvarez Quintero, Juan Valera, Ramón y Cajal, Pérez Galdós, Menéndez Pelayo and Segismundo Moret. Shrewdly, and leaving controversy aside, Cajal focused on Echegaray as a "pedagogue," that is, as a "brilliant scientific journalist, enthusiastic and incomparable communicator of the achievement of modern civilisation" (*El Homenaje a Echegaray*, 1905). According to Cajal "It is no mean feat to speak out eloquently in the free environment of the street about the fruitful truths extracted from Nature in the physician's laboratory. To disseminate abstruse science by diluting it, clarifying it and seasoning it with the condiment of art, so that it can be tasted by the uneducated masses and attract hearts and enlighten minds, is a difficult endeavour which calls for very special aptitudes, literary and teaching talents out of the ordinary" (Ramón y Cajal, 1905, p 127). He also mentioned Echegaray's great abilities as a teacher and lecturer. Cajal's speech appeared in *Madrid científico*. So he highlighted Echegaray's strengths; for proof, see the compilation published in 1905 entitled *Ciencia popular*, showing the award-winner's aptitude for

disseminating science (Echegaray, 1905).

After the homage to Echegaray, the next news appearing in the press regarding Cajal was about his receiving the Helmholtz Prize given by the Imperial Academy of Sciences in Berlin. It was an honorary award, without remuneration, but it contributed to boosting his popularity and prestige. On 10 March a letter appeared in *El Heraldo de Madrid* from his colleagues, the teachers of the Medical School in Madrid. They openly congratulate him and declare: "...and may we, your colleagues of this dear School..., be allowed, without stealing it from you, to borrow for ourselves the high honour you have received; because among us you are, with good reason, a beloved and revered brother. Because your name, home and abroad, purifies and brightens Spanish medical prestige. Because all of us, with your fame, live in the same house, breathe the same atmosphere, share the same joys and inconveniences while we teach and, above all, train the same brilliant, bustling and sensible youth" (*En honor de un sabio*, 1905). *El Imparcial* (10 March, p 1) noted that: "This recognition of intellectual and scientific Spain on the part of foreigners, and the tribute paid to our country through Echegaray and Ramón y Cajal, may well constitute a fine compensation for our misfortune", still bearing in mind the defeat of 1898.

The Helmholtz Prize joined the Moscow prize, awarded in 1900, and the invitation extended to him by Clark University, considered an act of moral revenge for the incidents between Spain and the USA not only by the government but also by public opinion. The press presented him as a "scientific hero" at that time. About this new prize, in Cajal's words, "I was astonished by the fact that the medal mentioned above was given every two years to the author who had completed the most important achievements in any branch of human knowledge. In awe and embarrassment, I read the list of laureates." (Ramón y Cajal, 1984, p 276).

It is worth noting that some newspapers, such as *El Liberal* or *El País* reported on the details of the medal – "it is of gold, of large diameter..."—apart from offering a few lines of biographical summary about Hermann von Helmholtz (*Premio a Cajal*, 1905; *Homenaje a Cajal*, 1905).

On 8 March 1905, *El Imparcial* announced that the centenary of the birth of Manuel García, the inventor of the laryngoscope, would be celebrated on 17 March, and that in London, where he lived, a great tribute was to be held¹. "In Spain, many people will not even have heard of him", the newspaper says, referring to a previous article written by Mariano de Cavia. It goes on to report that the Medical and Surgical Academy made him an honorary member, a title that he shared "with the wise Cajal, another Spaniard who is admired by the world" (García Tapia, 1905). On April the Valen-

¹He was born in Madrid on 17 March 1805 and died in London on 1 July 1906.

cian newspaper *Las Provincias*, in a long article commenting on politics in Madrid, talks about the disappearance of the paper *España*, and says: "In journalism, as in everything, in this obstreperous society of Madrid the louder you yell, the more talented you are, to such an extent that if the foreigners had not said Ramón y Cajal was a wise man, many would have ignored him. Here it is essential to give oneself the airs of an intellectual". (*La Política desde Madrid*, 1905). This is an interesting observation that gives an idea of the opinion of the provinces.

On 15 March 1905, on its front page, *El Imparcial* boasted that Sweden had given an award to Echeagaray, Germany to Cajal, and that London would pay a great tribute to Manuel García, of whom this paper offers some biographical information. Two days later, it re-emphasises the figure of Manuel García. It brought together the views of leading Spanish laryngologists, and it is striking that a certain Dr Forns says something that need not apply just to that moment of history: "We should learn a lesson", he writes, "from this example, after Cajal, Echeagaray, etc.: that for our national honour we should search out the men of valour who were born in Spain in order, by honouring and distinguishing them, to renovate and present our beloved nation to the world. Thus, dealing with this epidemic of cheap foreign things which is eating away at us, we will show off our finest products, which we have in great quantity and greater quality in our coffers. Those of us who still have a sense of shame will have no need to blush when other countries teach us to recognise our real coins from counterfeit ones, showing us the value of the treasures that we have hoarded as if we were savage tribes who, being uneducated, have no criteria properly to value what they own" (Forns, 1905). This was perhaps a reference to the Spaniards' inferiority complex in comparison with other countries.

La Vanguardia published a letter from the Medical Association of Gerona addressed to the other medical associations and the medical press. The purpose of this letter was to organise a tribute to Cajal, in the following terms: "It would be reasonable, in view of this honorary distinction, that all Spanish doctors should express our admiration to this sage who is so highly regarded by the Germans. I think that to extend our congratulations to the illustrious master it would suffice that on one day, on the first of May (marked as Labour Day, since Cajal works more than eight hours every day) each physician should send a postcard expressing their admiration, in a short phrase, for this distinguished Spanish histologist" (*El Colegio de Médicos de Gerona*, 1905).

Another subject that caught the attention of the press in 1905 was the anniversary of the publica-

tion of *Don Quixote*. The idea was not exactly from that year. In 1903, Mariano de Cavia in *El Imparcial* had called on the whole country to celebrate it two years after (Cavia, 1905). The anniversaries of remarkable personages had been celebrated before, but never the anniversary of the publication of a book. Perhaps it was a way to raise the spirits of the nation, still lamenting the catastrophe of 1898, or maybe it was something new. It is true that many European countries at the beginning of the twentieth century set out to extol their past glories with various commemorations, and Spain emulated that fashion.

This celebration was intended to highlight the Spanish resurgence and rapprochement with Spanish-speaking countries. The organisation was carried out by the State although, as was usual then, the government which appointed the Coordinating Board by decree would not be in power two years later. Finally, on 5 May, the official events began, accompanied by multiple initiatives all over Spain: lectures, exhibitions, special issues of magazines, publication of books, etc. There were new interpretations of the novel and new points of view, which can be summarised in two ways: those who considered it as representative of an old and backward country, and those who were closer to Cajal's opinion.

According to Laín (Laín, 1986, p 131), Cajal's contribution to the celebration (Ramón y Cajal, 1905b) is one of the occasions when it is possible to appreciate the scientist as he transcends the objective of his research. His lecture entitled "The Psychology of *Don Quixote* and Quixotism" represents the ideas of those who advocated the quixotic ethic as a basic resource to achieve the long-awaited regeneration of Spain. He suggested rescuing Spain from its prostration by cultivating science and technology with dedicated quixotic idealism. "Genuine Quixotism", he said, "has great scope for its practice in Spain". After explaining the different possible tasks with great eloquence, he added: "Here are the great and glorious adventures of our future Quixotes."

Another subject which affected Cajal that year was the vacancy in the Real Academia Española (Spanish Royal Academy) after Valera passed away on 18 April 1905. *El País* and *El Imparcial* talked about it² and supported Ramón y Cajal's candidacy, although they referred to Palacio Valdés, Valbuena, Mariano Cavia, Navarro Ledesma and Sánchez Pérez as other possible candidates. His sponsors were Francisco Silvela, José Echeagaray and Mariano Catalina. On 10 June *El País* complained that another vacancy in the Academy had been given to the former head of the Carlist newspaper *El Cuartel Real* and of *El Movimiento Católico*, Valentín Gómez, who had competed against Fernández Grilo. *El País* went on to say

²*El País*, 29 April 1905, p 2 and 6 May 1905, p2; *El Imparcial*, 5 May 1905, p 1.

that it hoped that the latter would not win against others who deserved the post, more specifically Cajal (At the Academy, 1905; Madrid, 1905). Finally, on the night of 21 June the Academy elected Cajal. However, he never took office. Some people point out that he was not very interested in it because the Academy had not supported Galdós for the Nobel Prize nor had it admitted Emilia Pardo Bazán. Some members such as Ortega Munilla and Carlos M. Cortezo tried without success to get him to formalise his incorporation into the Academy (Rodríguez, 1987, pp 59-60).

Alfonso XIII visited Paris in May of the same year. *El Heraldo* reported the articles published by *Les Annales Politiques et Littéraires* on the occasion of that event. The Spanish newspaper focused in particular on Maurice Barrès' article because it was "the most severe in its criticism and the least sycophantic about our regenerative forces" and said, "There is in Spain first-rate intellectual and hard-working youth, enthusiastic, diligent and capable of great efforts. In Madrid, in Barcelona, and in all the large capitals, in the south and in the north of Spain, I have been able to observe twelve years ago, five years ago, and just a few months ago, minds which are at least the equal of the best minds in Europe, temperaments of fighters who may very well be equal to the most "strugglers for life" in the western world". He then gives two examples: Cajal and Menéndez Pelayo (*España en París*, 1905). That same day the death of Silvela was announced. On 27 May, *El Heraldo* reported that the Royal Academy of Paris had elected Cajal as a corresponding member (Cajal en París, 1905). It reproduces some phrases from the French newspaper *Le Figaro* on the subject which are worth repeating: "Señor Cajal is one of the reformers of microscope science. He has studied with uncommon ingenuity the fine anatomy of the nerve cell. From his anatomical findings, he has deduced important conclusions on the functioning of our nerve centres. The name of Cajal is one of the most illustrious in modern neurology".

On 17 July 1905 *La Vanguardia* published news on the preparation of the Republican candidacies for the forthcoming election. "The candidature most likely to succeed is one that we might call intellectual..." comprised of people such as Pérez Galdós, Cajal, Estébanez, Blasco Ibañez, etc. (*Aprestándose para la lucha*, 1905). A few days later, on the 21st of the same month, *Las Provincias* reported Cajal's refusal to be part of the candidacy (*Candidatura rechazada*, 1905).

As well as the overall view given of Cajal's activity and prestige, other scientists showed in the press their discontent with Spanish reality. Doctor José Verdés Montenegro (1866-1942), who wrote in *El Imparcial*, published an article on 12 October in which he gave his impressions about the Con-

gress of Paris, which he attended with César Chicote, and in which, above all, the contribution of Behring was most notable. Verdés regrets the poor and non-existent participation of Spaniards on the subject of tuberculosis. This doctor reflects the same as has been said for decades, using Cajal as a reference: "Let us be simple, let us be humble, let us work. Let us not try to dazzle foreigners with sensational boasts. They know what happens in our country as well as we do; and to try to deceive them shows idle naivety. I trust all Spanish physicians in all aspects will manage to achieve the remarkable scientific work that Cajal has done in the speciality he cultivates. But we should not foster vanity in our youth, but love for learning. The day when in our class there are a hundred men, each of whom has the standing in his area that Ramón y Cajal has in Histology, our country will assert its authority over universal science, showing the way forward" (Verdés, 1905).

At the end of 1905, some newspapers such as *el Heraldo de Madrid* (20 December, p 1), were already reporting that Cajal had been proposed for the Nobel Prize for Medicine in 1905 and that he was one of the strongest candidates (Fernández et al., 1905). Other news, which this paper will not comment on, linked his name with the defence of Emilia Pardo Bazán's admission as an academician, his involvement in the *Liga Hispanoamericana de Instrucción Popular y de Propaganda Comercial* (Hispano-American League of Popular Education and Commercial Advertising), his participation in the *Asociación Antituberculosa Española* (Spanish Anti-tuberculosis Association), or the publication of his papers in the magazine *Trabajos de Investigaciones biológicas*, among others.

In contrast to what we find in the daily press in our study about the introduction of the medicine "Salvarsan" in Spain (Fresquet, 2011a and 2001b), where information was given about the scientific details (chemical, pharmacological and clinical), we have found little or nothing comparable about Cajal's works. Only the magazine *Nuevo Mundo* (20 July, p 5) mentions the "satellite cells" or interstitial cells of nerve tissue in a paper entitled "La vejez y su remedio" (Old age and its cure), in which, following Metchnikoff, Cajal explains this biological process.

THE YEAR OF THE AWARD OF THE NOBEL PRIZE

A review of the daily press of the time reveals that Cajal's name appeared in a multitude of speeches, from academic to political. For instance, Canalejas opened the course of the Academy of Jurisprudence with a lecture on "The state and the right of association". Giner de los Ríos, Costa, Azcárate, Cajal and Dorado Montero are men-

³*El Imparcial*, 22 June 1905, p 2 and *El País*, 23 June 1905, p 3.

tioned in the summary that includes authors' ideas on the subject (Academia de Jurisprudencia, 1906). For some time, the press had presented Cajal not only as a scientific reformer but also as a social reformer; he was becoming a living legend.

As had happened in 1905, the name of this histologist was also connected with the specific tasks of his profession. He was a member of examining boards, gave lectures; he was honoured by the Academia de Venezuela; Sorolla painted his portrait, which was presented with great success in the latter's exhibition in Paris, etc. Furthermore, news appeared of his appointment as a delegate by the Ministry, along with José Carracido, in the 14th International Congress of Medicine that was celebrated in Lisbon in April 1906⁴. He gave a lecture on the "Histogenesis of Nerves" that was highly applauded and extensively covered by the press⁵.

The Guatemalan journalist and writer Enrique Gómez Carrillo (1873-1927) published an article, "París. Como's españoles" in *El Liberal* on 5 April 1906, in which he alluded to the stereotypes of Spain that were still common abroad. He wrote it because of the book, *L'Espagne en Auto*, published in France. Gómez Carrillo criticised the fact that foreigners still wanted to see a Spain of matadors, of women with short skirts, red bodices and complicated mantillas, of conspirators, of paupers and lepers, and of gypsies, rather than a modern Spain, among whose achievements he numbers those of Cajal (Gómez, 1906). Concepción Gimeno de Flaquer (1850-1919), an advocate of women's rights, also wrote a piece referring to the Analytical Chemistry Congress that was taking place in Rome. She says that the Spanish representative there, the chemist Eugenio Piñerna, was widely acclaimed and that "Cajal and Piñerna's merits are more appreciated abroad than in Spain; we, the Spaniards, disdain our contemporary glories whereas we venerate historical ones" (Gimeno, 1906). This is, then, an opposite opinion to the former, and perhaps both fit into different social groups.

El Liberal on 17 April gave the news of the opening of the Instituto Lluria, belonging to the Cuban Enrique Lluria Despau (1863-1925), in Madrid. His friend Cajal attended the event. Lluria published the reworked speech of Cajal's admission as a member of the Academia de Ciencias (Academy of Sciences) entitled *Reglas y Consejos sobre la Investigación Biológica*. Profits would be invested in the setting up of the Cajal Institute.

In May, the press started to report rumours about the idea that Moret was thinking of offering Cajal a ministerial portfolio in the next government crisis. Juan Buscón wrote an article published in *La Vanguardia* on 8 May 1906 that summed up a general

feeling. It stated, "...more than once men are appointed to a Ministry who are of no use in that field, or another field, or any field at all; ministerial gold braid is given to real mediocrities, just by way of political reward or as satisfaction for the most daring or cadging". In the case of Cajal, Buscón says: "And it will always seem quite absurd to try to exalt and glorify a scientific eminence such as Ramón y Cajal by giving him for a few months the same award which is given to any ambitious or lucky carpetbagger. Does this distinguished Spanish intellectual really have any need to sit on a ministerial bench to gain greater prestige than he has already achieved in a far more beautiful field than politics?". He concludes by saying "Señor Ramón y Cajal: If Segismundo [Moret] offers you a portfolio when a new crisis arises, do not be tempted by such a miserable bauble..." (Buscón, 1906).

El País, *El Liberal*, and *Las Provincias* also run the story. The latter talks about assigning the Ministry of Communications to Cajal, seeking to imitate Montero Ríos who brought Echegaray back to active politics (*Asuntos del día*, 1906). *El Liberal* and *El País* on 3 May instead publish Cajal's refusal of the proposal of becoming Minister of Public Education, also based on hearsay. When the crisis arrived the news again appeared that the Public Education portfolio had indeed been offered to Cajal, and that he had refused it. His friend San Martín accepted the portfolio. *La Vanguardia*, based on *El Diario Universal*, noted that Cajal did not want to become a Minister but was being urged to become a life senator, and this newspaper wondered why they wanted him to get into politics when he did not want to (*Hojeando la prensa*, 1906). It was also mentioned that he was among the names considered to take charge of the Ministry of War (*La Vanguardia*, 5 June, p 8).

Cajal tells about his relationship with Segismundo Moret on those days when the latter spoke to him about the reforms he was willing to undertake in education. Captivated and seduced by the politician, Cajal pointed the way to some changes to rouse the University from its lethargy: recruitment of foreign researchers, residence for the best of Spanish youth in the most important places of European science, the establishment of schools attached to institutes and universities, the creation of a high-quality research organisation like the Collège de France, etc. (Ramón y Cajal, 1906, pp 282-287). When Moret came to power, he offered Cajal the portfolio of the Ministry of Education, and he did not refuse it; but on his journey to Lisbon, he reconsidered it and wrote to Moret to apologise and withdraw his promise. On 6 June 1906, Alejandro San Martín was appointed as Minister of Public Education and Fine Arts, as mentioned above. He remained in the Ministry just long

⁴Heraldo de Madrid, 29 March 1906, p 2; *El País*, 30 March 1906, p 3; *La Vanguardia*, 30 March 1906, p 7.

⁵*La Vanguardia*, 22 April 1906, p 9; *Heraldo de Madrid*, 24 April 1906, p 2.

enough to celebrate the good news, because one month later his service ended when Moret was defeated and replaced by José López Domínguez, who appointed Amalio Gimeno Cabañas to replace San Martín.

On Monday 2 July of that same year, one of the editorials in *El País* was entitled “El Alma Nacional” (The National Soul). The newspaper wondered whether there was a soul in the Spanish population, whether there was strength of purpose for those things that interested them. It mentions Cajal, who had declared himself despondent about the subject some time before. The population is not interested in government crises, or the dissolution of parliament, but they mobilise in defence of “los toros” (bulls): “There is only one thing: (...) – Bulls. Not the show with hired bullfighters; that is not the National Fiesta. The truly National Fiesta is when a whole town fights bulls; those never-ending fights with 12, 17 or more beasts and in which some people inevitably get bruised and injured”.

Summer was approaching, and the press drew attention to Cajal’s visit to Huesca at the same time as it announced his complaint against a caretaker of the Biological Research Laboratory for misappropriating 2000 pesetas (*Fraude de la Ciencia*, 1906) that were allocated to acquire materials. Cajal, Serapio Pérez and Sánchez Moguel, among others, arrived at Canfranc station on 16 August. Representatives of the City Council, deputies, doctors, the schoolteacher, military commanders, and the priest visited Cajal (*Sección de noticias*. Huesca, 1906). He did not go unnoticed: he had become a legend, and everyone wanted to meet him.

Again, on 19th August *El País* (p 1), and *Las Provincias* (p 3) reported that the Minister of Public Education had spoken in the Council of Ministers about an incident on the subject of the Institute of Serotherapy that had been entrusted to Cajal. Later, the press also gave the news of the subjects discussed during the Council of Ministers, among them the transfer of land in Moncloa to establish the Institute of Serotherapy, Vaccination, and Bacteriology that was run by Cajal (*Nota oficiosa*, 1906).

Among the opinion articles, one by José María de la Torre stands out. It is entitled “Género ínfimo”, in which he admits that Spain should be Europeanised, and that it takes both good and bad from other countries. As to the latter, he mentions how easily music halls and variety shows had spread throughout the whole country, “which the world is so fond of— shows with their half hoarse or completely hoarse divettes, their ventriloquists, their dog and cat tamers, and Spain is full of these concert halls, always packed with people, the

same public who have no idea what Nordau said about Sorolla, what the world of science thinks of Cajal, and who go into ecstasies over the sublime beauties repeated ad nauseam on thirty-cent post-cards” (*Crónicas rápidas*,...1906).

As Cajal said, “After a few months, when my relaxed and tranquil mind was once again enjoying the captivating surprises of silent and focused work, one October morning in 1906, still almost night, I was surprised by a certain laconic telegram issued in Stockholm and written in German...*Carolinische Institut verleiben Sie Nobelpreiss...*” (Ramón y Cajal, 1984, p 276). The press on 27 October 1906 published the news of the award of the Nobel Prize in Medicine and Physiology to Santiago Ramón y Cajal. *El Heraldo de Madrid*, for instance, placed this news on the first page, in one column, with a picture of the prize-winner along with a biographical sketch. *El Imparcial* did the same, but the story is not so long and includes a list of prize-winners from previous years to highlight the fact that “Just a few years ago, Spain learnt with surprise that it had a sage among its children. There was no doubt about the news because it received foreign approval. It was not until Cajal’s name was proclaimed worthy of admiration in the Academies and Universities of England, Germany and the United States that we in Spain felt obliged to declare him as being distinguished and to raise him above our traditional disdain and oblivion”.

No sooner had the news arrived than the students launched an initiative to pay homage to the prize-winner⁶. With this in mind they met in the amphitheatre of the Medical School in Madrid, and from the very first moment, the homage was intended to come from all the students in the country. Various different actions were proposed: from the beginning they talked about giving Cajal an album with the signatures of all Spanish students, organising a commemorative reception at the Madrid Athenaeum, crowning a bust of Cajal, and suggesting that the capital’s City Council change the name of Atocha Street to Cajal Street. In addition, the students talked about founding a hospital or clinic with his name by public subscription, dedicated to nervous disorders. A committee was chosen, and it was agreed that a letter should be written to all the provinces to arrange for their respective students to hold a tribute on the same day as Madrid; and also to the other faculties so that they could appoint a representative. In that first meeting, the resident students of the Athenaeum San Carlos and the Hospital and the socialist workers pledged their support. That day Cajal received a standing ovation from the students when he entered the class to teach; the same happened when he left the classroom. Afterwards, they accompa-

⁶Several newspapers echoed that news: *El Imparcial*, 28 October 1906, p 1; *Heraldo de Madrid*, 28 October 1906, p2; *El País*, 28 October 1906, p 1; *El Liberal*, 28 October 1906, p 1; *La Vanguardia*, 28 October 1906, p 8.

nied him to the Velasco Museum, where his laboratory was, and he was asked to come out onto the balcony. Cajal grudgingly thanked them but asked them to let him get on with his work.

The same day –28 October– *El Imparcial* published a letter from Alejandro San Martín, in which he called for the government to grant Cajal a seat in the Senate, as Silvela had done with Echegaray, arguing that a community is obliged to exalt its distinguished sons. It was also reported that, on a proposal from Calleja, the Senate wanted to express its satisfaction to Cajal for winning the Nobel Prize. It was Maestre who made the proposal in the Congress of Deputies and received the support of the Minister of Public Education and the rest of the Congress (Congreso, 1906).

The well-known columnist Mariano de Cavia dedicated an article to Cajal in *El Imparcial* on 29 October, where he points out: “The great and general delight produced by the triumph awarded to the distinguished histologist is without a doubt going to entail resounding events that will inevitably cause some annoyance to that humble and tireless worker. What can we do, Don Santiago? We have to take what comes, even if only because these sincere expressions of public admiration help to revive the spirits that have allowed themselves to be sadly overshadowed by the elegiac arguments of pessimism” (Cavia, 1906). This columnist also declares his support for the students’ proposal to change the name of Atocha Street.

More student meetings followed. The Medical Association, for its part, called an assembly for the 31st for the same purpose. The association later sent a representative to the student meetings. In the meantime, students from Barcelona, Valladolid and some other universities expressed their solidarity.

The elements originally foreseen for the tribute remained, only with some alterations. Agustín Querol (1860-1909) agreed to sculpt a bust of Cajal, to be placed in the amphitheatre of the San Carlos Medical School. He also waived payment for his work. The idea of the album with the signatures continued, and they even thought about publishing a book with some of Cajal’s work –for instance, his speech when he entered the Academy of Science– and from other authors in his honour. In addition, the idea was also discussed of creating an annual award for students, in Cajal’s name, for the best work on Histology or Pathological Anatomy, and the inmates of provincial and general charitable institutions wanted to publish a magazine in his honour. The idea of changing the name of Atocha Street by the City Council also continued, as did that of creating either a hospital or clinic dedicated to nervous disorders. The issue of the street name lost strength, since the law forbade using the name of anyone until after their death.

After studying the issue in the Parliament, it was decided not to make an exception and to give the name of the histologist to a new street⁷.

On 3 November *El País* reported that the City Council had expressed its solidarity with the outpouring of support and the events in honour of Cajal. The idea was also considered of popularising his work and requesting the government to make an exception in this case of naming streets with the names of living people.

As for the plans of the Medical Association, *La Vanguardia* echoed what was reported by *España Nueva*. In view of the proposals made, the newspaper declared that “as soon as half a dozen Spaniards meet, individual opinion and common sense turn into common nonsense” (*Hojeando la prensa. España Nueva*, 1906).

For its part, *Las Provincias*, from Valencia, on 3 November (p 2) announced that the City Hall would propose a tribute to Cajal, who was a professor of “our university,” at its next session. The University Senate supported the proposal, and the students wanted to hold some event in honour of the Nobel laureate. The following day, a large part of the front page of the Valencian newspaper was dedicated to the famous doctor. On the one hand, an article by José M. de la Torre deals with the subject of naming a street in Madrid after him; on the other, the city councillor and doctor Joaquín Aguilar Blanch proposes that the City Council create a kind of scholarship with the name of Cajal. This article explained that the way to win it would be through competitive examination, with a selection board of four professors from the Faculty and the Health inspector or assistant inspector from the City Council. Doctors who had finished their studies not more than five years earlier would be the candidates; the scholarship would consist of 3000 pesetas for furthering their studies in Bacteriology and Micrography in the laboratory of the Institute Alfonso XIII, led by Cajal, and doctors who obtained the scholarship would get a credit if they wanted to achieve a job as a doctor. *El País* reproduced the whole letter on 6 November 1906, and it states, in addition to the above, that Valencia should be the first to offer him a tribute, as he began to teach for the first time in the University of that city.

La Torre’s article completing the page of *Las Provincias* notes that Spain is not like other countries that honour their intellectuals: “We have never taken an interest in our wise men. For us to discover that Cajal was a great eminence in research into the cells of the complicated and obscure nervous system we needed science journals from all over the world to inform us. What is more, Spain is mean when it comes to rewarding merit. Since there are so few Spaniards who actually possess merit, when our country sees (or is shown) an ex-

⁷Heraldo de Madrid, 3 November 1906, p 3; *Las Provincias*, 4 November 1906, p 1.

traordinary man among the thousands of mediocre and useless people who appear as eminences it should reach out and protect him, not with ridiculous subsidies, nor gold medals, nor great crosses that put him at the level of any run-of-the-mill-senator, but by establishing from the State budgets, so often squandered, a decent amount of money to honour the country itself, honouring and protecting either talent or inspiration...It is disgraceful that...Spain has only given him, to extend and practise his studies, a yearly subsidy whose amount is only equivalent to what a famous matador gets for just one bullfight or what an average tenor earns in a week of shows" (De la Torre, 1906b).

The students of Valencia organised themselves very quickly. They convened their first meeting on the evening of 6 November (Escolares. Los alumnos de medicina, 1906). They agreed to support what the City Council was doing in proposing that a street could be marked with Cajal's name, and decided to organise an evening reception or demonstration in honour of the famous scientist to seek the cooperation of student associations. On the 10th all the student representatives of the city met in the Science Athenaeum to finalise the details (Escolares, 1906). The Valencian students agreed to join those from Madrid not only to present Cajal with an album with their signatures, but also in asking the City Council to name a street after the professor and to accept Aguilar's proposal; to commission an artist to make a parchment containing the names of the representatives of students and the scientific, worker and recreational societies of Valencia; to organize a mass demonstration on the same day as Madrid and, in the evening, a scientific and literary reception in his honour. The president of the Unión Escolar, José Uxó, reported that the University Senate had agreed to appoint Cajal as Honorary Dean of the Medical School, to name the dissecting room after him and to erect in that room a plaque to commemorate the fact that he gave his lessons there and, finally, to inform him of these agreements in the minutes of the meeting (Homenaje a Dr Cajal, 1906).

Concerning the name of the street, a subcommittee of students visited the then mayor, Doctor José Sanchis Bergón, who informed them that the street then called "Torno de San Gregorio" could be named after the sage. There was a debate in the City Council between the supporters of changing the name of an existing street (either Torno de San Gregorio, San Vicente or Garrigues) and the proponents of naming a new street, since "The distinguished sage should be honoured, not with old clothes, but with new ones" (Ayuntamiento de Valencia, 1906). On 18 November, the terms and

conditions of the scientific and literary competition were published in the press. The delivery of originals was postponed until 12 January 1907, and the soirée was scheduled for the 26th of that same month.

Meanwhile, the groups of students were still active in Barcelona, Madrid and Valladolid, accompanied by those from Granada, Cordoba, and Cadiz, and later by those from Seville. Those from the capital, gathered in the San Carlos Medical College, agreed to go ahead with the proposals as mentioned earlier, and to open a subscription to deal with some of the costs. (En honor de Cajal, 1906). A group also visited the Minister of Public Education to persuade him to take part in the tribute they were preparing (Varias noticias, 1906). For its part, on 18 November the Medical Association brought together representatives from sixty-eight scientific, literary, academic, and teaching bodies in its head office, with the aim of constituting a committee that to agree on how to solemnise the awarding of the Nobel Prize to Cajal. Julián Calleja, Miguel Moya, José Francisco Rodríguez, Rafael Conde Luque and Mariano de Cavia formed part of that committee.

At about that time, the National Tenured Medical Assembly took place in Madrid, and they also wanted to pay tribute to Cajal. The idea emerged from Aragonese doctors, but everybody wanted to participate. Canalejas closed the meeting with a speech in the evening of the 24th. The session ended with cheers of support for Cajal and Canalejas and for medicine. There was a banquet to which the general press was invited, and where a toast was offered to Cajal, who received a committee to thank them for their congratulations⁸.

El Heraldo de Madrid on 1 December reported Cajal's departure for Stockholm to receive the Nobel Prize. El Imparcial, El Liberal, and El País did so the following day. He left in the afternoon, and students from all faculties went to the Norte Station in Madrid with their banners to bid him farewell, not without some problems with the police. His family and representatives of the professors also went to the station. San Martín, Isla, Decref, Rodríguez, Antón, Cabrera, F. Reyes, and others were among the members of the delegation.

The tributes began to materialise before the end of the year. It seems that one of the first homages took place in Zaragoza, specifically in the Teatro Pignatelli (Homenaje a Cajal. C, 1906). There was a student rally in the Teatro Pizarro of Valencia on 2nd December to organise a National Student Congress, encouraged by Francisco Moliner. He said that students, being young, are those who have the best qualities and who may undertake the best campaigns in favour of Spanish culture. He also justified the desirability of celebrating the Na-

⁸Heraldo de Madrid, 22, 23, 24, and 25 November 1906, pp 1, 2, 2, 2 respectively; El Liberal, 23, 24 and 26 November 1906, pp 3, 2 and 2 respectively; El Imparcial, 24 and 25 November 1906, p 2 and 2; El País, 25 November 1906, p 2.

tional Congress to deal, on the one hand, with the matter of the stability of the ministers of Public Education and, on the other hand, with academic discipline. He proposed, in the first place, to send a telegram of support to Cajal: "The students of the University of Valencia, gathered in a grand meeting in the Teatro Pizarro to deal with the celebration of a National Student Congress devoted to education issues, agreed, amid great acclamation when they heard your name, to greet you respectfully and with the greatest enthusiasm, the distinguished professor of this University and the great Spaniard, whose knowledge and glory are great enough to compensate Spain for the shame and misery that she suffers for other reasons. Please receive, illustrious and caring professor, this greeting both modest and enthusiastic from the University of Valencia, the cradle of your glory". Telegrams were also sent to Amalio Gimeno, former Minister of Public Education and Senator, and Navarro Reverter, Minister of Finance. Later they walked through the streets with their banners, cheering for Cajal, Gimeno and Reverter (Mitin escolar, 1906).

Pulido wrote an article on Cajal for *El Heraldo de Madrid*, which was published on 12 December along with a photo of the histologist looking through the microscope. It is entitled "Doctor Cajal". In his article Pulido placed on record that the newspapers had not stopped talking about him since 1894, in connection with the many honours that he received from national and international institutions. The writer of the article admits that Cajal's science "may never be popular because he does not have many readers even among doctors and naturalists themselves...".

Then he gives a biography of Cajal. When Pulido alludes to Cajal's fame and success, he remembers what Cajal himself stated: "Do only one thing; but do it well, and if possible, better than anybody else. Carry out intensive work in a limited area, without deviation or distraction caused by subjects different from the topic in question". Afterwards, he compares two different and opposing personalities, Cajal and Letamendi. The former is an analytical person and the latter is synthetic. Pulido considers Cajal to be of a solid temperament with a solidly forged character, a laboratory worker; Spartan and sincere. "Those who examine his whole work and the way he performs it and presents it to the public will find that nothing surpasses his transparency, simplicity and the honest sincerity of his offer". From the very beginning Cajal harvested original fruits and general respect. Pulido also says that Cajal needed support and an institution (a laboratory of bacteriology and histology) as well as to create disciples, because "if he does not do it, we doubt that anybody will". He also refers to and later repeats the opinions of Cajal's disciple Tello about

the fact of setting precedents. "He was accompanied by many at different times, attracted by his success...but as soon as they were called away by more compelling incentives they gave up, leaving the master to his solitude and his hopes".

El Imparcial reported on the same day that Cajal had arrived in Stockholm on Saturday 8 December in the same train as his fellow prize-winner Henri Moissan (1852-1907), a French chemist. The news includes some of the opinions that the *Stockholms Dagblad* had published after an interview with Cajal. *Las Provincias* of the same day reported on the previous day's ceremony of presentation of the awards to Cajal and Golgi, to the physicist Joseph John Thomson, to the chemist Moissan and to the man of letters Giosuè Carducci (whose award was collected by a representative from Italy). The rest of the newspapers joined in offering information about Cajal's stay in Stockholm on 14 December and the consecutive days⁹. Others also mentioned the lecture he gave about the anatomy of nerves in the Academy of Sciences of Stockholm ("Estructura y conexiones de las neuronas"). *El Imparcial* of 15 December, under the headline "The champion of peace", criticised Theodore Roosevelt (1858-1919), president of the United States of America, for winning the Nobel Peace Prize.

THE TRIBUTES OF 1907 AND THE RETURN TO "NORMALITY"

On 3 January, *El País* reproduces the article that Joaquín Costa dedicated to Cajal in the special issue of *La Clínica Moderna* entitled "Optimistic Cajal". About him he says: "Lavishly endowed with faith, tenacity and unsurpassable mastery at unravelling the secrets of Nature in the processes of the infinitely small, he sought to succeed and after tough battles he has finally triumphed, projecting streams of light into the gloom of the world of the brain, no less marvellous than the stellar world, hand-in-hand with his fellow countryman Miguel Servet over a gap of three centuries, with the effect of incorporating the name of our nation into universal science". On the subject of Cajal as a politician, as a person capable of holding a ministerial portfolio, Costa says: "Politically considered, our sage is no foundling, no blank slate: he professes well-defined political ideas, even when he has always refused to cooperate in their spread and success so as not to be distracted from his creative microscope... In Cajal, the man goes hand in hand with the sage, his seriousness and firmness of character with his mental potential. Together with a scrutinising and clairvoyant mind he has a refined stomach that would never allow him to wallow in the mud of the oligarchic, praetorian cliques of politics that vilify us, or arch his noble spine before an authority of mistrust which has

⁹*El Imparcial*, 14 December 1906, p 3; *La Vanguardia*, 14 December 1906, p 8; *Las Provincias*, 14 December 1906, p 3.

destroyed Spain, with a slap in the face to his brethren who fundamentally counted on him so long ago when they asked for a commitment to mercy, to unselfishness and genuine sacrifice, frustrated by the lack of such conditions" (Costa, 1907).

In January the press also refers to the composition of the "Committee for the Extension of Studies"¹⁰. The *Gaceta de Madrid* published the name of the 21 people who made up that committee; Cajal was appointed as chair, Gumersindo de Azcárate and Leonardo Torres Quevedo were named vice chairs, and Castillejo, from the department of technical information and foreign affairs of the Ministry, as secretary. Amalio Gimeno Cabañas was the Minister by then¹¹. On 22 June the *Gaceta de Madrid* published the rules governing this committee¹².

Cajal received several tributes throughout January 1907. The press tells us of the homage carried out in Córdoba, organised by the *Círculo La Amistad*, and that in Palma de Mallorca, organised by the *Círculo Médico-farmacéutico* (The Medical-pharmaceutical Circle). The tribute celebrated in the *Teatro Principal* of Valencia in the evening of 28 January deserves special mention. Authorities and representatives not only from the University but also from other educational institutions and scientific circles of the city attended the event. The prizes for the students were awarded; Juan Batural – who was considered as Cajal's Valencian disciple – read a speech in which he recalled the years when his master was in Valencia, already dedicated to research; José María Zumalacárregui and the student president of the organizing committee, Señor Uxó, spoke later. Pedro María López, the dean of the Faculty of Philosophy and Letters, closed the event on behalf of the rector¹³.

Magdalena Santiago Fuentes published a notable article in *La Ilustración Española y Americana* dedicated to refuting "depressing Spanish pessimism" (Santiago, 1907). She points out that foreigners value our country more highly, and takes as reference the work by Manuel Borges Grainha, professor of the *Liceo Central* of Lisbon, who had just published *La instrucción secundaria en Portugal y en el extranjero*, based on material collected through fieldwork in different countries. Borges Grainha recognises the progress made in Spain in recent years, the widening of arts education, the increasing culture of the Spanish woman... "Spain takes the problem of education and national instruction very seriously" despite disadvantages such as the excess of theoretical education over

practical, the shortfall of suitable facilities, etc. Furthermore, he highlights the progress made in industry, agriculture, trade, and sciences that would be greater if it were not for "the exalted spirit of its people, who partly abandon themselves to exaggerations of religious fanaticism, and partly embark on the anarchistic revolutionism that is undermining Andalucía and Cataluña". He goes on to say that "Despite the difficulties, there is a predominant, working, thoughtful and intellectual class in Spain who tries to transmit life and energy to the nation, lift it up after the colonial disasters of the recent war, an extremely harsh, humiliating and maybe useful lesson that seems to have calmed down the quixotic longings of past ages, bringing it to the reality of modern life." Afterwards, he gives examples such as Cajal, Echegaray, Menéndez Pelayo, and many others.

In the meantime, the preparation of tributes in the capital of the country continues to be reported. It is worth noting the visit that the tribute committee paid to Maura, president of the Council of Ministers, to ask him for a Senate seat for Life for the Nobel Prize laureate. This committee was composed of its chairman Francos Rodríguez, Calleja, Conde y Luque (the rector), and senators San Martín and Sanz Escartín. A popular subscription was started to cover the expenses of the medal.

Federico González Brigabert published the article "Private Cajal" in *El País* on 4 February. He wanted to give a different image of our Nobel winner from the public one. González Brigabert said that if anyone dropped by Cajal's laboratory in Atocha where he worked, they would see that Cajal made his preparations without any fear of getting his hands dirty or ruining his clothes, and without needing his assistants. He deals with his vast daily correspondence and writes pages of notes that later become his works without any secretary. His pride – notes González Brigabert – is in his work, for which he submits himself to an exaggeratedly rigorous regime. Compliments, honours, and tributes paid to him "do not exist for him." A sign of his nature is that he paid from his pocket the money the head porter stole in his High School. González Brigabert adds another anecdote. On one occasion, the sole of Cajal's boot came off. An improvised shoemaker offered his help to mend it, but Cajal grabbed his tools and solved the problem himself. When he is at home away from his work, "he is naïve, with that naivety of a man who, the duty of his profession done, knows how to fulfil the sacred duty imposed by the family."

On 20 March, *La Vanguardia* announced the

¹⁰*Heraldo de Madrid*, 12 and 15 January 1907, pp 3 and 2 respectively; *El País*, 14 and 17 January 1907, pp 5 and 2; *El Imparcial*, 16 January 1907, p 2; *La Vanguardia*, 16 January 1907, p 8; *Las Provincias*, 16 and 18 January 1907, pp 3 and 3.

¹¹Royal Decree creating a Committee for the Extension of Studies and scientific research. *Gaceta de Madrid*, no.15, 15 January 1907, pp 165-167 and Royal Decrees naming Mr Santiago Ramón y Cajal, etc... as spokesmen of the Committee for the Extension of Studies and scientific research. *Gaceta de Madrid*, no. 15, 15 January 1907, p 167.

¹²*Heraldo de Madrid*, 21 June 1907, p 4; *El País*, 22 June 1907, p 5; *La Vanguardia*, 22 June 1907, p 7.

¹³*Las Provincias*, 17, 19, 20, 27 and 29 January 1907, pp 1, 1 and 3, 1, 2, 2, 1 respectively; *El País*, 29 January 1907, p 1; *El Imparcial*, 30 January 1907, p 3. Photograph of the event in *Nuevo Mundo*, 7 February 1907, p 21.

launch of the magazine *Cajal* that included the Nobel Prize winner's best works. The *Heraldo de Madrid* gave a piece of more specific information about it on 6 April. It was issue number 7 of the journal *Revista de Medicina y Cirugía de la Facultad de Medicina de Madrid "Cajal"*. It contained works by several authors, including Ramón y Cajal himself. 6809 pesetas had been collected at the beginning of May, but it was agreed to extend the collection, while commissioning the medal from Benlliure¹⁴.

The Medical Association continued to organise the tribute to Cajal while Calleja left the chair after fourteen years and Ángel Pulido (Albarracín, 2000, pp 80-82 and 85-90) was elected. The open subscriptions continued¹⁵. A commission made up of Calleja, Gimeno, San Martín, Olóriz and Gómez Ocaña drew up some rules for the contributions that would be part of a tribute book to Cajal¹⁶.

In May, Cajal visited the Minister of the Interior to talk about the necessary reforms that had to be undertaken at the Instituto de Sueroterapia Alfonso XIII that he headed, a subject that was also reflected in the press¹⁷.

On 7 May 1907, *Las Provincias* reproduces an article by Miguel Oliver (Miguel dels Sants Oliver 1864-1920), in *ABC*, entitled "La solidaridad catalana". The article refers to the clichés sold to Spanish people, such as separatism, antimilitarism, etc. "Those who shout ¡Viva España! loudest are not those who want it more. Often enough the Pharisaic spirit is involved in these acclamations rather more than the nobly patriotic". What counts, he adds, are "...eminent Spaniards of this time; I read their works; I look at this silent Spain of great spirits who in their offices, in their university chairs, in laboratories, or in their stubborn pedagogical work bravely defend their position in the modern world, each one in their speciality or from their political, philosophical and academic point of view". Cajal is obviously mentioned among them.

On 14 May a party of students from Valencia arrived in Madrid on the mail train from Aragon. They brought Cajal a book of signatures that they would leave in the Centro Regional Valenciano on Calle de la Bolsa, so that Valencian people who were in Madrid could sign. They gave him the book at a reception that took place at the Centre on 22 May. The rector of the University of Madrid offered its auditorium, but Cajal preferred the other place. Luis Cerveró, the president of the Regional centre,

spoke, as did the well-known student Uxó, who detailed the works carried out and talked about the enthusiasm generated by the initiative in Valencia. Later, to the sound of the Valencian hymn, the album was given to Cajal. Deeply moved, he paid a tribute of gratitude to Valencia. Abelardo Vidal (secretary of the centre) gave him the title of honorary member. The congressman Eduardo Vilar and minister Rodríguez-San Pedro gave the closing speeches¹⁸.

There were other tributes and gifts to Cajal such as that offered by a Committee of the directors of the Centre for Workers' Societies in Calle Relatores¹⁹. He was also invited to form part of the Honorary Committee of the International Congress of Alienists that would be held in the Netherlands the following September²⁰.

Another important event in Cajal's life was also reflected in the press. This was his reception at the Royal Academy of Medicine that took place on Sunday evening, 30 June. Cajal had spent ten years preparing his speech about the "Mechanism of nerve regeneration"; his friend Federico Olóriz responded to it. The event ended with a few words from the then Minister of Public Education, Faustino Rodríguez-San Pedro²¹.

The year 1907 ended with the budget discussion in the Spanish Parliament, especially the Public Education Budget. On 15 December, *El Imparcial* said that it was going to be one of the most important debates, calling for the attention of patriots and thinkers "interested in the fact that such a praised national restoration should be more than a mere cliché". Therein lay the real national problem. Despite long past experience, things would go no further than eloquence, words, and speeches that would swell the parliamentary library. "There is no government in Europe more fruitful in legislative initiatives, in theoreticism, in eloquent verbiage than the Spanish government". The debate on the budget of Public Education was left to the last minute, although it was "the one to provide the means for those intelligences to arise and these efforts to bear fruit". It is forgotten that even in international wars, as in everything, science triumphs; recent lessons have fallen on deaf ears; those beautiful words (which should be written in bronze in Parliament), with which Ramón y Cajal described the process of our "debacle" and pronounced the indisputable verdict of his real opinion: "The triumph of the Yankees over us repre-

¹⁴*Heraldo de Madrid*, 6 May 1907, p 2; *El Imparcial*, *El País*, and *La Vanguardia*, 7 May 1907, pp 3, 5 and 8 respectively.

¹⁵*El Imparcial*, *El Liberal*, and *El País*, 12 April 1907, pp 1, 2, 4 respectively.

¹⁶*El País*, and *La Vanguardia*, 5 May 1907, pp 5, and 7 respectively.

¹⁷*El País*, 13 and 17 May 1907, pp 3 and 5; *Las Provincias*, 13, 17, 19 and 21 May 1907, pp 2, 2, 3, and 3; *Heraldo de Madrid*, 21 May 1907, pg. 1; *La Vanguardia*, 18 and 22 May 1907, pp 8 and 8.

¹⁸*El País*, 13 and 17 May 1907, pp 3 and 5; *Las Provincias*, 13, 17, 19 and 21 May 1907, pp 2, 2, 3 and 3; *Heraldo de Madrid*, 21 May 1907, p 1; *La Vanguardia*, 18 and 22 May 1907, pp 8 and 8.

¹⁹*Las Provincias*, 6 June 1907, p 3; *El País*, 7 June 1907, p 3.

²⁰*La Vanguardia*, 21 June 1907, p 6.

²¹*El País*, 27 June, and 1 July 1907, pp 5 and 1; *Heraldo de Madrid*, 30 June 1907; *El Imparcial*, 30 June, and 1 July 1907, pp 3 and 1; *El Liberal*, 1 July 1907, p 2; *La Vanguardia*, 1 July 1907, p 3; *Las Provincias*, 1 July 1907, p 3; *Nuevo Mundo*, 11 July 1907, p 3.

sents the victory of science over ignorance, of foresight over neglect” (El Consejo de ayer, 1907). This was going to be the first year without students being sent to study abroad since 1901, while more advanced nations provided generous amount of money for that chapter of the budget. We were going to be worse than Turkey, it was said. “The scientific eminences that are hampered in their work by bureaucratic hurdles”. Some members of Parliament pointed out, however, that the Barcelona Provincial Council and the City Council had allocations for studying abroad, something that was also confirmed in other cities.

Some of the news items and articles are a demonstration of what Cajal himself wrote: “... telegrams of congratulation; letters and messages of good wishes; tributes from students and professors; commemorative diplomas; honorary distinctions given from scientific and literary corporations; streets named after me not only in cities but also in one-horse towns; chocolate, anisette and other potions of questionable hygiene, labelled with my name; offers of great involvement in risky or fanciful businesses; intense pressure for ideas for making albums and autograph collections; requests for jobs and sinecures...; there was everything, and I had to accept it, appreciating and deploring it at the same time, with a smile on my lips and sadness in my soul” (Ramón y Cajal, 1984).

At other times his name in news and articles was related to social and political aspects. Some opinion articles mention him not only to show that Spaniards did not recognise their intellectuals whose merits were admired by foreigners, but also to criticise the stereotypes with which those same foreigners valued Spanish society. Both approaches still apply.

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The new lifeblood of the Spanish nation: the Regenerationist Movement and the genesis of the Cajal Institut in the late 19th century

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SUMMARY

Different external or sociological factors play a part in the development of scientific institutions and it is not uncommon for them to be more decisive than the internal or scientific factors. This paper analyses the significance of one of those external factors in the genesis of the Biological Research Laboratory (Laboratorio de Investigaciones Biológicas), which was the seed of the future Cajal Institute (Instituto Cajal): the development of the regenerationist political movement that emerged during the Spanish crisis of the late 19th century.

Using sources from the field of journalism, three points in the formation of the Biological Research Laboratory are studied: 1. The appearance of the press's first demands for a laboratory or institute for Cajal during 1898 and 1899, starting in the new publications linked to regenerationism that emerged during those years; 2. The launch, on foot of Cajal receiving the Moscow Prize, of an intense press campaign for the foundation of that laboratory or institute in the summer of 1900, run by the daily press that was most closely linked to political regenerationism; and 3. The speedy establishment of the Biological Research Laboratory just over two months after the beginning of that campaign, in November 1900, by a government eager to maintain its regenerationist image.

The paper concludes by confirming the decisive

role played by the rise and fall of the regenerationist political movement, built around the National Union party (Unión Nacional), at these three points in the laboratory's formation.

Key words: Cajal Institute – Biological Research Laboratory – Santiago Ramón y Cajal – Spanish scientific institutions – History of Spanish science – Regenerationism – The Spanish crisis of 1898 – 19th-century Spanish press

INTRODUCTION: AN INFLUENTIAL INSTITUTE OF NO FIXED ABODE

The Cajal Institute (Instituto Cajal) originated from the Biological Research Laboratory (Laboratorio de Investigaciones Biológicas), founded on 16 October 1900 by Royal Decree and on foot of Santiago Ramón y Cajal's (1852–1934) receipt of the Moscow Prize in August of that same year. The Biological Research Laboratory was set up in 1902 on the second and third floors of a wing of the old Velasco Museum, today the National Museum of Anthropology, located close to the Atocha Railway Station in Madrid. The research centre, created specifically for Cajal and the first one in Spain dedicated to neurological research, was a relatively small space, but supplied with good resources and an abundant library (González Santander, 2003a). There, Cajal developed the work initiated in the histology laboratories of the Faculty of Medicine in Madrid (Cerrato Ibáñez, 1983), and trained numerous disciples who would form the 'Spanish histological school' (González Santander, 1996, 1997, 1998, 2000, 2003b, 2005, 2006b).

Following a Royal Decree issued by Alfonso XIII in February 1920, just a few years before Cajal's retirement, the Biological Research Laboratory

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became the Cajal Institute and would be provided with new premises of a scale sufficient for Cajal to carry out his work. The building in question began to be erected in 1922 on the San Blas Hill, bordering the Retiro Park on the south-east side, and very close to the Museum of Anthropology, but due to endless difficulties, it was not finished until 1933. Semi-demolished during the Civil War (1936-1939), the Institute was partially recovered in 1941 and affiliated to the Spanish National Research Council (CSIC). In 1957, the Cajal Institute moved to a new location on Calle Velázquez, which would end up becoming the Biological Research Centre (Centro de Investigaciones Biológicas), where it shared the space with other research institutes (González Santander, 2006a; Borrell, Ferrús, García Segura, 2007; Borrell, 2010). Lastly, in 1981, it moved to new premises on Avenida Doctor Arce, where it is currently located.

Several studies have addressed the significance of Cajal, his work, his institute and his school for contemporary science, culture and society; studies which have continued to be produced at a steady pace in recent decades (Illing, 2002; Garmundí, Ferrús, 2006; De Carlos, Pedraza, 2014). However, some aspects of the Cajal Institute are hardly considered in the research. One such aspect is the influence of sociopolitical factors on its formation, an issue dealt with in depth by very few studies (Lewy Rodríguez, 1987). This paper, following and adding to other previous work (González de Pablo, 1998), aims to fill that gap, studying the role played by the regenerationist political movement and journalistic media in the genesis of the Cajal Institute during the final years of the 19th century.

THE SCIENTIST AS THE NATION'S SAVIOUR

During the fin-de-siècle crisis, crystallised in the Treaty of Paris of 10 December 1898, which obliged Spain to grant independence to Cuba and to give up Puerto Rico and the Philippines to the United States, the endemic shortcomings in Spanish science were often highlighted by regenerationism as one of the fundamental causes of the national asphyxia to which the shock defeat was attributed (Abellán, 1989; Carr, 2009). Therefore, creating science came to be seen in public opinion as an indispensable remedy for recovery of the national malady (Fernández Cicero, 1898). This consensus view resulted in a growing appreciation of scientists in the national press, especially of these researchers respected abroad, but who still lacked their due recognition within our borders. One of the most significant cases in this regard was Cajal's (Pomro, 1899).

Indeed, before 1898, Cajal already enjoyed international renown. His 'new truth' (the individuality of the nerve cell), established in 1888, had gained him numerous honours, such as his invitation from

the Royal Society of London to give the Croonian Lecture or his naming as Honorary Doctor by the University of Cambridge in 1894 (Ramón y Cajal, 1981), which had laudatory comments in the press. But it was during the final years of the 19th century that Cajal's media presence increased significantly. The press insisted then on his role in renewing science, reflecting his new awards. The most significant were the Rubio Prize awarded by the Royal Academy of Medicine (*La Correspondencia Médica*, 8 January 1897) and the Fauvelle Prize from the Society of Anthropology of Paris (*El Siglo Médico*, 7 March 1897). His nomination as elected fellow of the Royal Academy of Medicine also featured (*La Correspondencia Médica*, 30 November 1897), as well as his acceptance to the Academy of Exact, Physical and Natural Sciences (Carlán, 1897).

Moreover, the print media most closely linked to regenerationism, eager for figures that would serve as an example for the nation's revival, no longer limited themselves now to presenting him as a renowned scientist, but also as a social reformer, turning Cajal into a type of hero-saviour of the dying homeland.

On the basis of the political considerations voiced by Cajal himself in the media, the press also highlighted his role in regenerating Spanish society. The opinions of scientists on the regeneration of the homeland were held in especially high regard in the media during the fin-de-siècle period, as they were considered to be uncontaminated by the spurious individual and group interests of politicians. Cajal, following this trend, published some newspaper articles dedicated explicitly to the regeneration of the country throughout the final third of 1898 and the beginning of 1899, which had significant impact: the article that appeared in *El Liberal*, in the series 'The country speaks' (26 October 1898), which was partially reprinted in the *Heraldo de Aragón*, in the series 'New men' (27 October 1898), and in full in *La Correspondencia Médica*, in the section 'Folleto' (16 November 1898); and the article that appeared in the *Heraldo de Aragón* in the series titled 'What do you think of, fear, hope for in 1899?' (Ramón y Cajal, 1899).

Like other positivist and progressive-thinking doctors that wrote about the country's regeneration in the newspapers (Carlán, 1898; Lloria, 1898; Trigo, 1898), Cajal, whose name was circulating as a potential candidate for senator in the 1899 elections, based his articles on the Krausist consideration of society as a living organism (Abellán, 1989). Following this view, fin-de-siècle Spanish society was a sick organism that had to be diagnosed and treated properly with a series of measures, which Cajal had already stressed in some of his texts (Ramón y Cajal, 1995). Together with those measures, Cajal repeatedly drew attention in his media contributions to the need to create science rather than merely transmit it, or else

face the misery, backwardness and degeneration of the nation. For this purpose, it was absolutely indispensable 'to generously equip scientific laboratories, appointing sufficient staff for original studies and experimental teaching' (Ramón y Cajal, 1898).

THE DEMANDS FOR AN INSTITUTE TO INJECT NEW LIFE BLOOD INTO THE COUNTRY

By disseminating his awards, nominations, activities and political opinions during the final years of the century, the press had turned Cajal into a model for curing the fading nation. And, in order for the country's healers to carry out their revitalising mission, they needed better resources to perfect their scientific work and to develop their full potential for the country's revival. As a result, the press also began to make demands for the provision of these necessary resources for Cajal, at the forefront of which (in line with the formulas proposed by Cajal himself, as indicated in the quote at the end of the previous paragraph) was the provision of an institute or a laboratory that he could call his own.

In order to assess the effectiveness of these media demands and campaigns at that time, we have to bear in mind that the press began to become truly powerful in the last quarter of the 19th century. This process coincided with the replacement of the dominant opinion newspaper (dependent on parties, movements or personalities) by company-owned newspapers, which were conceived as businesses and set up as public limited companies (Seoane, Sáiz, 1996). The growing influence of the press rested upon these company-owned newspapers, which referred to themselves as 'independent'. Unlike the opinion newspapers, they covered much more varied subject matter and, for the purpose of increasing readership, kept an ambiguous political discourse. That is not to say that they did not defend any political positions, since the main newspapers of this kind (*La Correspondencia de España*, *El Imparcial*, *El Liberal* and *Heraldo de Madrid*) always had an ideological dimension (Seoane, Sáiz, 1996).

All of these major newspapers, beyond their liberal or conservative tendencies, defended the system and offered a restrained and serious aesthetic. Alongside them, and among several other types of print media, there were more radical publications that criticised their silencing stance. Aside from the workers' press, these publications included republican newspapers, such as *El País* or *El Progreso*, and socially-committed regenerationist magazines, such as the weekly *Vida Nueva*.

The initiatives in favour of creating the Cajal Institute originated in the regenerationist magazines, then gained support in the independent or company-owned press, and only later also appeared in professional medical publications.

The first precise and unequivocal demand for an

institute for Cajal was made on the pages of the weekly regenerationist publication *Vida Nueva*. The magazine, whose existence was brief (it was published from 12 June 1898 until 18 March 1900), aimed to be an open platform for all ideas that brought 'new lifeblood' to the nation. As part of that new lifeblood, and following the example of what France had done with Pasteur, the publication's first issue advocated providing the wise Cajal with an institute where he would have access to all possible resources for research and teaching, thus creating a higher education institution. The aim was for the proposal to have a national scope and to bring together all types of participation, both public and private (Elleide, 1898). Two issues later (*Vida Nueva*, 26 June 1898), the publication reiterated the demand for the Cajal Institute in a short piece and highlighted the magazine as a point of connection for all people, corporations and bodies that wished to contribute to that national endeavour in the name of gratitude and regeneration.

This first initiative faded as the months passed, but the cause gained momentum once again at the beginning of 1899 when the Ateneo cultural association, at its general meeting on 4 January, approved a project for the creation of a 'Laboratory of biology, experimental psychology and anthropology' within the organisation and under the direction of Cajal and other recognised scientists. The decision was covered and highly praised in *El Liberal* two weeks later. It claimed that, with this practical proposal, the Ateneo would also become the nation's 'first scientific centre', contributing decisively to 'the country's regeneration by means of instruction, which is an endeavour it is deeply concerned with and interested in' (Ateneo member, 1899).

Although the Ateneo's proposal did not prosper, it resulted in the so-called independent newspapers joining the crusade for the institute. However, it would not be until the summer of 1899, on the occasion of Cajal's trip to Clark University in Worcester, Massachusetts, that the demands would extend beyond the general-interest magazines and newspapers to the medical press (though still in a very lukewarm way). Thus, *La Correspondencia Médica*, in a short piece about that trip (24 June 1899), demanded that the government grant Cajal 'the assistance and independence granted to all wise men by their respective nations, [who] are not only provided with allowances and resources for material and staff to help them, but also independent and lucrative positions'. At the same time, the weekly publication *Vida Nueva* (17 September 1899) used the news of the trip to revive the appeal launched a year earlier for the Cajal Institute and to put forward, for the purpose of guiding its creation, the establishment of 'a committee of doctors, professors and writers that would receive the backing of any Spaniard interested in these genuine and legitimate national treasures'.

THE MEDIA OFFENSIVE: AN INDEPENDENT STATE INSTITUTE

After these first efforts, we reach the decisive month of August 1900, when, due to his receiving the Moscow Prize, a definitive offensive was launched for the creation of a laboratory or institute for Cajal.

On 8 August, in the closing ceremony of the 12th International Congress of Medicine held in Paris, Cajal was awarded the City of Moscow Prize, a triennial distinction that the Moscow Faculty of Medicine had established for the best work in the biological sciences. On foot of the prize (and reinforced by mention of Cajal's discoveries and their significance for national regeneration), a strong campaign was immediately launched for the creation of a laboratory or institute for Cajal, especially in the 'major press', made up of the independent or company-owned newspapers.

El Imparcial published two front-page articles written by two of its most influential writers: Mariano de Cavia (1900) and the director of the newspaper, José Ortega Munilla (1900). Both pointed to the need for an institute or laboratory for Cajal, highlighting the scarcity of the resources with which the learned man was obliged to carry out his research.

On its front page, the *Heraldo de Madrid* released an interview with Cajal which was conducted in his home, located at that time in the Cuatro Caminos neighbourhood (Muñoz, 1900a). The next day, another front-page article complemented this interview, commenting on Cajal and his research work (Saint-Aubin, 1900). Both highlighted his lack of a laboratory and the losses he was caused by publishing his work, asking without further delay for the creation of an independent laboratory or that Cajal be granted a personal subsidy that he could access as he wished.

El Liberal (10 August 1900) covered the news of the prize in a short front-page piece, which ended exclaiming: 'the distinguished histologist, who began his admirable work with a meagre microscope and a razor, still has no major laboratory and loses money publishing the immortal works needed to disseminate his science and teaching throughout the world!'

The republican *El País* (19 August 1900), for its part, highlighted that the 'establishment of the Cajal Institute is urgently needed', in an article that appeared the week after the prize was awarded.

Among the provincial newspapers, the *Heraldo de Aragón* was perhaps the most enthusiastic, first publishing a tribute to the learned man (Lozano, 1900). A little later (10 August 1900), it published a new unsigned article giving an account of a warm letter from Cajal to the editorial office, providing more details on the events surrounding the Moscow Prize and noting the government's efforts to provide the distinguished intellect with a laboratory

and funding. Lastly, it ended with another extensive piece on Cajal's contributions to neurology and his importance for the regenerationist spirit (Morote, 1900).

Magazines also contributed to the campaign. *La Ilustración Española y Americana* dedicated a piece to it at the end of August, pointing to the righteousness of providing 'a decent income for such a modest leader [and an] ad hoc building for him to continue his research and receive the foreigners that are constantly requesting to work with him' (Miñambres, 1900).

This time, the medical press collaborated with the cause from the outset. *La Correspondencia Médica* was the most vehement. In one article, it demanded that a laboratory be set up for Cajal at all costs, since 'producing national science' was the condition for being respected in the world (Márquez, 1900). In another piece, it demanded the creation of the Cajal Institute before the celebration of the 13th International Congress of Medicine in Madrid in 1903 (Calatraveño, 1900a).

In any case, the media campaign for the Cajal Institute unleashed in the summer of 1900 was now much more concrete and no longer limited itself, as had been the case during the first efforts of 1898 and 1899, to vague calls for a scientific institute that would serve as a reference point for national regeneration. There were now three precise demands. Firstly, the institute's funding should be charged to the state budgets, promptly making any reforms of current legislation needed if this could not be undertaken legally (Saint-Aubin, 1900). Secondly, the institute or laboratory should be completely independent and Cajal should be able to direct it as he wished: 'Spain, not Cajal, has a need or an interest in this distinguished wise man having the independent position he deserves, with a laboratory set up as he pleases, and with freedom to spend' (Muñoz, 1900a). Therefore, the funding for the institute or laboratory had to be personal, 'as a form of income, without anyone having the right to investigate whether he uses it to further his studies or to dig in his garden with an elegant top hat on his head' (Saint-Aubin, 1900). In addition, the funding could also be improved by private initiative, through a 'national subscription that should be opened for the establishment of the Institute' (Calatraveño, 1900a). Thirdly, the founding of the institute should be accompanied by an allowance or pension that would allow its director 'to live decently, without any worries distracting his attention and dedicating himself fully to scientific research' (Márquez, 1900).

THE ESTABLISHMENT OF THE BIOLOGICAL RESEARCH LABORATORY

The press campaign had an almost immediate effect, and the conservative government of Francisco Silvela was very receptive to the demands.

Thus the process began for the legal establishment of what would be the Biological Research Laboratory, which lasted just a little over two months, from the beginning of August until mid-October 1900. This process was followed in detail—one could almost say scrutinised—by all of the independent newspapers.

The process began on 11 August with the agreement of the Council of Ministers, on the motion of Marcelo Azcárraga, Minister for War and acting president, to grant as much as necessary to supply Cajal with 'a laboratory in line with the advances of science, where he may continue his research for the benefit of humanity and the honour of Spain', as *El Imparcial* covered the next day (12 August 1900). It was also agreed that the Minister for Finance (Manuel Allendesalazar) and the Minister for Public Works (Rafael Gasset) would put together a report to study how to provide the eminent wise man with the resources to establish that laboratory at the expense of the state.

The report proposed three formulae for this purpose: 1. Creating a biology laboratory directed by Cajal and with the support staff that he deemed indispensable; 2. Providing him with a subsidy to broaden his studies in his official laboratory at the San Carlos Royal College of Surgery; or 3. Granting him a strictly personal subsidy to establish his laboratory. The last option was the one chosen, since the first (the report argued) would give rise to another official body that would restrict Cajal's freedom and would need to be maintained once he was gone; and the second could give rise to unnecessary antagonism and protests among the academic corps (Gasset, Allendesalazar, 1983).

Once this document had been studied, it was agreed at the Council meeting of 22 August that the Minister for the Interior, Eduardo Dato, would meet with Cajal to determine the needs arising from the laboratory's establishment, as covered in *El Liberal* (23 August 1900) and *El Imparcial* (25 August 1900), among others. Cajal visited Dato on the morning of 24 August at the Ministry of the Interior and in that meeting they agreed to create a scientific research department within the Serotherapy, Vaccination and Bacteriology Institute (Instituto de Sueroterapia, Vacunación y Bacteriología), also known as the Alfonso XIII Institute, of which Cajal was director since the end of 1899, at least in name.

A new Council meeting was held on 1 September (*El Liberal*, 2 September 1900). In it, it was agreed to grant a subsidy of 50,000 pesetas for the creation of the research department at the Alfonso XIII Institute and its supplies; to allocate 30,000 pesetas per year for its maintenance; and to provide an annual income of 10,000 pesetas and a house for Cajal. With this news, the legal process also began to be covered in the pages of the medical press (Carlán, 1900a, 1900b; Calatraveño, 1900b).

However, despite the agreements of the Council on 1 September, the process was far from concluded. The Alfonso XIII Institute did not meet the conditions to house Cajal's laboratory, and the cost of its refurbishment would be exorbitant. On the other hand, the criticisms of neglect (Verdes Montenegro, 1900a) and inefficiency in the development of vaccines (Verdes Montenegro, 1900b; Muñoz, 1900b), which had emerged at that time contributed to the rejection of new departments at the centre.

This setback meant that different proposals were considered for the possible location of Cajal's laboratory. Several councillors from Zaragoza, as reported by *El Imparcial* (11 September 1900), presented a motion to open a popular subscription for the purpose of creating a Cajal Institute in Zaragoza. Another initiative considered by some members of parliament was to offer Cajal the laboratory of the new San Juan de Dios Hospital. The idea was not hare-brained, since the laboratory's pavilion, specifically built for that purpose, had cost 350,000 pesetas and 'vast and extremely valuable material had accumulated there' (Verdes Montenegro, 1900c). However, like the other offers, it went no further than a mere suggestion.

Despite these setbacks, the Council of Ministers, at its meeting on 13 October, finally approved 'granting a subsidy of 80,000 pesetas for a scientific research department at the Alfonso XIII Intravenous Fluid Therapy Institute, which is directed by Ramón y Cajal' (*El Imparcial*, 14 October 1900). This news was covered in all of the independent press the next day.

That, however, could not be the location, for the reasons just given, but the issue of funding was resolved. The decree granting the subsidy was signed by Her Majesty the Queen on 16 October and it was published in the *Gaceta de Madrid* (Official Gazette of the Spanish State) on 21 of the same month (Carlán, 1900c). The decree stipulated that the one-time payment of 80,000 pesetas was allocated 'to establish the biological research service under the direction of Dr D. Santiago Ramón y Cajal'. That is: the location of its premises was left open and the service was linked exclusively to Cajal, granting him full autonomy in how he managed the subsidy.

In an endeavour to follow the funding model of the Pasteur Institute (Weindling, 1992), which was the basic initial reference point for the Cajal Institute, there were new efforts to complement the state subsidy through private donations. The main one came from engineer Pablo de Alzola, then Director-General for Public Works. Alzola sent a letter to the Minister for Public Education, Antonio García Alix, reprinted in the *Heraldo de Madrid* (17 November 1900), in which he proposed opening a public subscription organised by the Central University, which he himself would start with 500 pesetas. However, although the proposal was also

publicised in *El Imparcial* (18 November 1900), *El País* (18 November 1900) and the *Heraldo de Madrid* (20 November 1900), the attempt did not bear fruit.

In short, the legal establishment of the initially titled 'Biological Research Service' in October reflected the three fundamental demands of the press campaign carried out in August: its state funding; its independence (linking the laboratory specifically to Cajal had the advantage for the government of not having to maintain the institution once Cajal was gone and it left Cajal with full freedom to manage it); and the provision of an annual income of 10,000 pesetas for its director, which, at Cajal's own request, was reduced to 6,000 pesetas, an amount that remained unaltered in 1930 (Albarracín, 1982).

Lastly, once the Royal Decree for its establishment was approved by the Congress and the Senate, the Biological Research Laboratory was first set up in a hotel on Calle Ventura de la Vega. In 1902, on the initiative of the Count of Romanones, successor to García Alix in the Ministry of Public Education after the arrival of Mateo Sagasta's liberal government in March 1901, it moved to the Doctor Velasco Museum, where it remained definitively.

THE CAJAL INSTITUTE AS A SYMBOL OF REGENERATIONISM

As discussed so far, from 1897 onward, Cajal's visibility in the print media increased progressively. In 1898 and 1899, that growing presence was accompanied by appeals for a research institute or laboratory similar to Pasteur's in France. In August 1900, the demands reached considerable intensity, developing into a genuine press campaign which led to the legal establishment of the Biological Research Laboratory in November of that year.

However, despite the melodramatic claims of some of the articles published in the press at that time in relation to the scarcity of the resources he worked with, the histology laboratories of the Faculty of Medicine in Madrid were reasonably well equipped and allowed Cajal to develop his work in a way that was perhaps not ideal, but was at least acceptable. Therefore, the campaign for the Cajal Institute and its success were due less to internal scientific causes than to external social ones. And those social causes were very closely linked to an intellectual and political movement that gained particular momentum in the fin-de-siècle crisis: regenerationism.

Regenerationism was a political and intellectual movement that meditated on the causes of Spain's demise as a nation and tried to solve them (Saz, 2016). Its main representative was Joaquín Costa from Aragón (like Cajal) with his famous motto summarising the solutions needed for the country's revival: 'School, provisions and a double lock on

the tomb of El Cid' ('Escuela, despensa y doble llave al sepulcro del Cid'); that is, education and science, a new economic model without oligarchies which ensure resources for the whole population, and the refounding of a modern Spain with no traditional burdens or ties. It is also worth bearing in mind that regenerationism was a middle-class movement with a cross-cutting nature, which brought together conservatives and progressives, traditionalists and republicans.

The emergence of regenerationism was due to the intense dissatisfaction of the middle classes with the ineffective political situation which had been brought about after the 'disaster' of 1898. This dissatisfaction was worsened by a tax policy that was made responsible for these classes' financial distress. It was among these middle or 'neutral' classes, as they were called at the time (since they were neither oligarchy nor proletariat), where regenerationism emerged. This movement demanded changes in education and in science, but also reforms in fiscal policy and in public spending. Seeking to satisfy these demands, in November 1898, the Chambers of Commerce joined together, led by the glass industry businessman Basilio Paraíso and the publicist Santiago Alba. In addition, the National League of Producers (*Liga Nacional de Productores*) was established in February 1899, headed by Joaquín Costa (Cacho, 1997; Peiró Martín, 2012).

At the end of June 1899, the tax reforms introduced by Silvela's cabinet, which raised the much-hated indirect taxes on food, drinks and fuel, led the Chambers of Commerce to promote a tax refusal campaign, resulting in a general protest that lasted until the beginning of July. Given the relative success of the protest, the decision was taken in January 1900 to transform the Chambers of Commerce into a political organisation: the National Union (*Unión Nacional*), with Paraíso as president and Alba as secretary. Costa's National League of Producers would also join the National Union soon afterwards (Balfour, 1987).

This entire process of the development of the regenerationist movement, culminating in the formation of the National Union, was surely decisive for the emergence of the media's first demands for an institute or laboratory for Cajal, who was presented as a symbol of regeneration. The Cajal Institute was the main image of the new lifeblood needed to revitalise Spain.

In May 1900, the National Union called for a new tax refusal campaign, which again gained considerable support (*Heraldo de Madrid*, 1 June 1900). The government soon adopted a repressive stance, first with the closure of the Chambers of Commerce and incarcerations (*Heraldo de Madrid*, 16 June 1900), and later decreeing the suspension of constitutional rights (*Heraldo de Madrid*, 21 June 1900). Despite all of this, the disturbances continued until mid-July. On 17 July, Paraíso had

to put an end to the protest and at the same time presented his resignation as president of the National Union (*Heraldo de Madrid*, 18 July 1900). Paraíso, Alba and Costa continued their political activity (the first two on the liberal side and the latter on the republican side), and the National Union would still hold a party conference in Barcelona in 1901. But the rebellion of the middle classes had definitively failed and with it regenerationism as a political force, although it still kept its intellectual influence alive.

The frustration around this setback meant that, when news of the Moscow Prize came in August 1900, three weeks after Paraíso's resignation, the demand for a laboratory for Cajal seemed like compensation for the middle classes' defeated regenerationism (Cajal belonged to that neutral class, he had shown himself to be a regenerationist sympathiser on more than one occasion and Costa and he professed their mutual and public admiration). The demand for Cajal's laboratory during that torrid summer of 1900—to which it is quite likely Cajal himself contributed behind the scenes, as one is led to suspect by the correspondence he kept with some newspaper editors (Ramón y Cajal, 1900)—allowed the forces of renewal, which were unfocused and dejected after their defeat by the government, to briefly reunite. This explains the tributes paid to Cajal at that time by the middle classes (*El Imparcial*, 4 October 1900; *Heraldo de Madrid*, 4 October 1900), as well as how the campaign for the laboratory was led by the newspapers that most actively supported the National Union (*El Imparcial*, *El Liberal*, *Heraldo de Madrid*, and *Heraldo de Aragón*).

Therefore, the reaction to the collapse of political regenerationism helps identify some of the reasons for the impetus with which the campaign for the laboratory was launched in the summer of 1900. However, an explanation is still needed for why the government, which had been so uncompromising in the previous months with the regenerationists, gave in to this new demand and granted the funding for the laboratory's establishment within the very short period of two months.

In the search for that explanation, we must bear in mind that Silvela's government had come to power on 3 March 1899, presenting itself as the leader of the much longed-for regeneration, a term which Silvela himself had even tried to monopolise in August 1898 (Silvela, 1898; Seco Serrano, 2005). At the first signs of change, however, it was clear that its reformist programme was more façade than reality (*El Socialista*, 17 March 1899; *Heraldo de Madrid*, 10 May 1899). Somehow, nevertheless, the government resisted the growing political unrest. It tried to improve its reformist image with some ministerial changes, such as the departure of one of its most conservative members, Luis Pidal y Mon, from the Ministry of Public Works (*El Liberal*, 19 April 1900). However, from

the end of June 1900, with the suspension of constitutional rights, its reformist image was definitively wiped out (*Heraldo de Madrid*, 20 July 1900).

The cabinet's extremely unstable situation explains the speedy agreement—made on 11 August in response to the first attacks from the press—to provide Cajal with the resources to create his laboratory. The provision of funds for the laboratory, 'the only good deed by the government in the whole period' (*El País*, 12 August 1900), meant a break from its difficult political situation and a brief respite from the press's attacks.

The break in hostilities was, however, fleeting and very soon they resumed with increased intensity (*El País*, 10 September 1900; *Heraldo de Madrid*, 20 September 1900). On 19 September, the suspension of rights decreed on 20 June was finally repealed. Even so, the government's days were numbered. The definitive crisis, with Silvela's replacement by Azcárraga at the head of the government, happened one month later, on 21 October (*El País*, 22 October 1900), the same day that the subsidy for Cajal and his laboratory was published in the *Gaceta de Madrid*.

CONCLUSIONS

In summary, the genesis of the Biological Research Laboratory, the future Cajal Institute, was closely linked to the emergence and evolution of political regenerationism, for which the reform of national education and science were essential components. The press's demands to provide Cajal with his own laboratory or institute gained more and more visibility throughout 1898 and 1899, coinciding with the progressive development of the regenerationist political movement, which culminated in January 1900 with the formation of the National Union. These demands first started to appear in the media most closely linked to regenerationism and only later did the professional medical press get on board.

The frustration generated by the blow to the National Union in July 1900 resulted in the launch of a genuine press campaign for the establishment of an institute or laboratory linked to Cajal (after he received the Moscow Prize in August of that year). To a large extent, this was a way to compensate for the defeat inflicted on reformism by the conservative government of Francisco Silvela a few weeks earlier. In fact, the campaign for Cajal's laboratory was driven by the newspapers that had most actively supported the National Union (*El Imparcial*, *El Liberal*, *Heraldo de Madrid* and *Heraldo de Aragón*).

In contrast to the severity shown towards regenerationist demands in the previous months, which even came to the provisional suspension of constitutional rights, Silvela gave in very quickly to this demand in an attempt to mitigate the growing social malaise as much as possible. Although with

this measure he managed to soften criticism during a brief period, in the medium-term he could not avoid the crisis in his cabinet. His replacement as head of the government took place on 21 October 1900, the date on which the founding decree for Cajal's Biological Research Laboratory was officially published in the *Gaceta de Madrid*.

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Cajal in Barcelona: From yesterday to today, from the neuron to the network

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SUMMARY

The synaptic and network theories of memory, which Cajal first advanced in Barcelona around 1890, have been firmly established and elaborated by three generations of neuroscientists. This article outlines a corollary model of memory in the cerebral cortex that derives from those theories and is empirically supported by modern functional methods. The model posits that the elementary unit of memory or knowledge is a network of neurons of the cerebral cortex associated by life experience according to Hebbian principles of synaptic modulation (a cognit). Networks or cognits of perceptual memory are hierarchically organized and distributed in posterior association cortex; those of executive memory, also hierarchically organized, are distributed in frontal association cortex. In the course of goal-directed behavior and language, perceptual and executive cognits engage in the perception-action cycle, the cybernetic cycle that dynamically links the cortical cognitive networks with the environment in the pursuit of goals. The prefrontal cortex, at the summit of that cycle, and interacting with cortical and subcortical structures, guides behavior and language to their goals by means of its executive functions of planning, executive attention, working memory, decision-making, and inhibitory control.

Key words: Memory – Cognit – Cerebral cortex – Perception – Action cycle – Prefrontal cortex – Planning – Executive attention – Working memory – Decision-making – Inhibitory control

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From 1887 to 1892 Cajal was professor and chairman of Histology at the University of Barcelona. He took that position after his 4-year chairmanship of Anatomy at Valencia, where he started his careers as a microscopist. Judging from his



Fig 1. Engraving of the Hospital of the Holy Cross, site of the old medical school of the University of Barcelona, when and where Cajal was professor of histology. At the beginning of the 20th Century, the school was relocated to new quarters. (Professor Valentín Carulla Margenat, the author's maternal grandfather, and Rector of the University of Barcelona, nominated Cajal to honorary membership in the Royal Academy of Medicine of Catalonia.)

own account (Cajal, 1923), his five years in Barcelona were some of the most satisfying and productive of his scientific career. Figure 1 shows an old engraving of the Hospital of the Holy Cross (founded in the year 1401), which housed the medical school where Cajal taught histology.

It was in Barcelona that Cajal seriously initiated his research on the nervous system. For an excellent description of the cultural and scientific environment of Barcelona in Cajal's time, the reader is referred to Ferrer, 1989. Before he came to Barcelona to work on the nervous system, Cajal had done interesting if unremarkable histological studies in other areas, notably in tissue inflammation. Two factors, however, played a decisive role in that shift of his interest. One was a visit he paid to the laboratory of Luis Simarro (Fig. 2), a prestigious neurologist and psychiatrist in Madrid, who was proficient in the Golgi method of staining nervous tissue by use of silver salts. Simarro taught Cajal how to use the method, which Cajal later improved for his seminal discoveries. The second factor was a beautiful Zeiss microscope that the City Council of Valencia gave him as a present in recognition for his scientific assistance during a cholera epidemic in their city. Cajal thus came to Barcelona with powerful new research tools, and full of enthusiasm to study the fine anatomy of the nervous system.



Fig 2. Simarro showing visitors how he uses the Golgi method (bottle of silver cromate in the foreground). Painting by Joaquín Sorolla (Museum Sorolla, Madrid).

The images of fine nervous tissue that the Golgi method provides are extremely precise but notoriously partial and arbitrary; the method stains only a small, random sample, of the cells in a histological preparation. Despite this limitation, Cajal was able to identify for the first time, in innumerable preparations, the structural individuality of nerve cells, which was the basis of his neuron theory. Here are excerpts of what he writes about that discovery during his second year in Barcelona: “And the year 1888 arrived, my top year, my year of fortune. For in that year, which arises in my memory like the blush of dawn, . . . the new truth emerged,

. . . the so-called netlet was not intracellular, but intercellular.” (Cajal, 1923, pp. 199 and 205). Thus, what Golgi had construed as a network of interstitial tissue made of seamlessly united neurons Cajal concluded was a network of contiguously—not continuously—connected neurons.

While gathering Golgi stains from a large variety of nervous tissue preparations, Cajal engaged in a prodigious amount of scientific activity. The following are his most significant accomplishments in Barcelona: (a) he creates his own scientific journal, the *Revista Trimestral de Histología Normal y Patológica* (Fig. 3); (b) he publishes some 50 articles on new findings in assorted nervous structures (cerebellum, retina, muscle spindles, spinal cord, etc.), in birds and mammals; (c) he carries out several trips through Europe, establishing contacts with a score of foreign scientists (His, Golgi, Retzius, Waldeyer, Kölliker, Azoulay, etc.), whom he tries to convince of the significance of his findings; (d) he begins to publish in French and German; (e) in March 1892, in the Barcelona Academy of Medical Sciences, he delivers a lecture in which he presents the conceptual outline of the famous Croonian Lecture, which he would pronounce two years later in the London Royal Society (Cajal, 1894), hosted by Charles Sherrington; (f) he begins the preparation of his “Magnum Opus,” *Texture of the Nervous System of Man and the Vertebrates* (Cajal, 1899/1904).

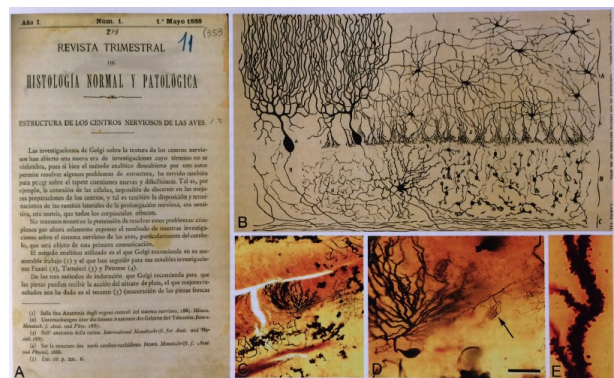


Fig 3. On the left (A), first page of the first number of the quarterly journal that Cajal founded in Barcelona in 1888. On the right (B-E), Golgi stains from the cerebellum of the chicken. (From DeFelipe, 2014, with permission).

Friedrich Hayek, the famous economist (Nobel Prize winner in Economics in 1974) and erstwhile psychologist, used to say, “Without a theory the facts are silent.” This is an evident truth in all the sciences. Nonetheless, theories are based on facts, and it was on the basis of his observations of the contacts between neurons (the word synapsis did not yet exist, it was introduced by Sherrington in 1897) that Cajal theorized on the formation of memory in the central nervous system. This is what he thought in Barcelona, and said in 1894 at a neurology congress in Rome, about the organism's acquisition of motor memory (Cajal, 1923,

pp. 288-289): "The functional improvement resulting from exercise (physical education, speaking, writing, piano playing, fencing, etc.) . . . [is caused by] the creation of new cellular appendices, allowing the adjustment and extension of contacts between neurons and even the establishment of entirely new relations between neurons that are not originally connected."

More than half a century would pass before these ideas would be theoretically elaborated in functional terms by Hebb (1949) and Hayek (1952), and would find empirical verification in invertebrate as well as vertebrate nervous systems. The central hypothesis in all of them is, as Cajal postulated, that synaptic plasticity and neuronal branching are at the root of memory formation. Stimuli arriving in a neural structure at the same time, or nearly the same time, enhance the transmission capability of the synapses between the neurons that represent the stimuli in that structure. The synaptic changes at the foundation of that enhanced capability constitute the structural foundation of memory. Consequently, once a memory has been formed in this manner, the arrival of one of the stimuli originally associated in its formation will evoke the recall of the other(s). In the cerebral cortex, the highest level of the nervous system, those synaptic associations between stimuli form, as the result of life experience, an immense conglomerate of neuronal networks. These networks can be best characterized as cognitive networks or, as I call them for short, "cognits." Inasmuch as memory serves all cognitive functions in addition to memory (attention, perception, language and intelligence), cognits constitute the essential neural structures that those functions utilize.

Studies of the neuropsychological effects of brain lesions, single-neuron recording in the primate and neuroimaging in the human have yielded extensive knowledge concerning the formation and organization of cognits in the cerebral cortex. In other publications (Fuster, 2003, 2009), I have reviewed the relevant empirical evidence in support of that organization. Therefore, in this paper I will limit myself to presenting the principles of cognit formation, the organization of cortical cognits, and their functions in purposive behavior.

CORTICAL ORGANIZATION OF COGNITS

Essentially, a cognit is a network of cortical neurons that represents in its totality a memory or item of knowledge. It is generated by the enhancement of the contacts between neurons, as Cajal proposed for memory in general. That connective enhancement is the result of the temporal coincidence of neural inputs from sensory, motor and emotional systems associated by life experience. There is experimental evidence that, by repeated experience, learning and memory not only facilitate synaptic transmission but also the recruitment

of cells into the network by dendritic expansion, spine proliferation and ephaptic (axon-to-axon) contacts.

The memory network, formed by self-organization, is therefore a relational representation defined by its cellular and connective structure. In psychological terms, the represented material can adopt many forms on account of the variety of possible inputs that contribute to the formation of its cognit: it may be an episodic memory, a fact, name or concept (semantic memory), a motor skill (procedural memory) or an emotional experience. Most cognits, however, are mixed, in that their networks encompass a variety of associated inputs. Contributing further to the variety of cognits is the variability in the strength of the connective links that form them. This variability in connective strength depends on several extrinsic and intrinsic factors, such as input intensity, relevance, emotional valence, associations with prior individual experience and rehearsal (Fuster, 2009).

It is a truism that in the cerebral cortex every neuron is connected, directly or indirectly, to every other one. Indeed, the entire neuronal substrate of the cortex can be construed as an immense network of interconnected neurons. There is, however, exquisite structural and functional selectivity within it. The neuronal assemblies of the primary sensory and motor cortices constitute a large sector of that network. These assemblies are the genetically inherited product of evolution. Elsewhere (Fuster, 2003) I have argued that the primary sensory and motor cortices and their cell assemblies can be considered the "structural memory" that the organism is born with. For that reason I call it "phyletic memory" or "memory of the species." It is a form of cortical memory, thus of cortically stored information, because it contains the functional architecture that the organism's predecessors, in eons of evolution, "learned" to use to adapt to the world and to ensure survival and procreation. With that view in mind, the "content" of that memory is made of the feature-detector and motor cell assemblies of sensory and motor cortex, respectively. Another component of that "phyletic memory" is constituted by subcortical limbic structures that serve and protect the emotional and instinctual life of the organism.

In the mammalian brain, the memory of the individual organism, in neuropsychological terms, is acquired in the form of cognitive networks, that is, cognits, that grow into association cortex out of primary sensory and motor cortices. It is thus appropriate to infer that individual memory grows with every life experience on a base of phyletic memory. In anatomical terms, therefore, cognits grow out of primary cortex into the cortex of association of the temporal, parietal and frontal lobes. The formation and expansion of each cognit generally follows two anatomical and developmental gradients: (a) the cortico-cortical fiber pathways

from primary sensory or motor cortex to posterior or frontal association cortex, and (b) the direction in which cortical areas and their nerve fibers undergo myelination before and after birth. For those cognits to form and consolidate in the neocortex, certain limbic regions of the brain, notably the hippocampal formation and the amygdala, are necessary. By mechanisms that are still poorly understood, these two limbic structures provide cognitive and emotional inputs that serve the neocortex to engrave and consolidate experience.

The size of a cognit and its distribution over the cortical surface depend on the distribution of its associated neuronal assemblies. As a result, the cognits—memory or knowledge—of an individual vary widely in magnitude and cortical distribution. Further, because different life experiences share associated stimuli, different cognits share different groups of neurons together. Consequently, a neuron or group of neurons almost anywhere in the cerebral cortex can be part of many memories or items of knowledge (semantic memory). In this sense, the model here outlined is akin to the modern connectionism of artificial intelligence (AI).

On account of the enormous variety of cognits in the brain of an individual, and because multiple cognits share associated attributes in common, the cortex of association houses a multitude of overlapping and interactive cognits of varying size and cortical distribution. Nonetheless, that distribution is not totally arbitrary. The clinical and experimental evidence of the last two centuries clearly indicates that memories and knowledge are hierarchically organized, and so is their neural substrate. The cortical hierarchies of memory and knowledge acquired through the senses (perceptual memory) extend from primary sensory areas to the association cortex of the temporal and parietal lobes. Conversely, the hierarchies of cognitive representations of action (executive memory) extend from primary motor cortex to the association cortex of the frontal lobe—premotor and prefrontal (Jackson, 1958).

The dichotomous distribution of perceptual cognits in posterior cortex and executive cognits in frontal cortex has phylogenetic and functional origins. That differential distribution is the cortical extension of the dichotomy that prevails throughout the nerve axis, from the spinal cord upwards: sensory structures in the back, motor structures in the front (with some exceptions, e.g., the cerebellum, which has sensory in addition to motor functions).

The highly schematic diagrams of Fig. 4 illustrate the cortical gradients of formation and distribution of perceptual and executive cognitive hierarchies projected onto the surface of the cortex of the left hemisphere. Despite inter-hemispheric differences with regard to certain cognitive functions and the memory material, notably verbal, which those functions work with, we can assume the same general distribution in the right hemisphere.

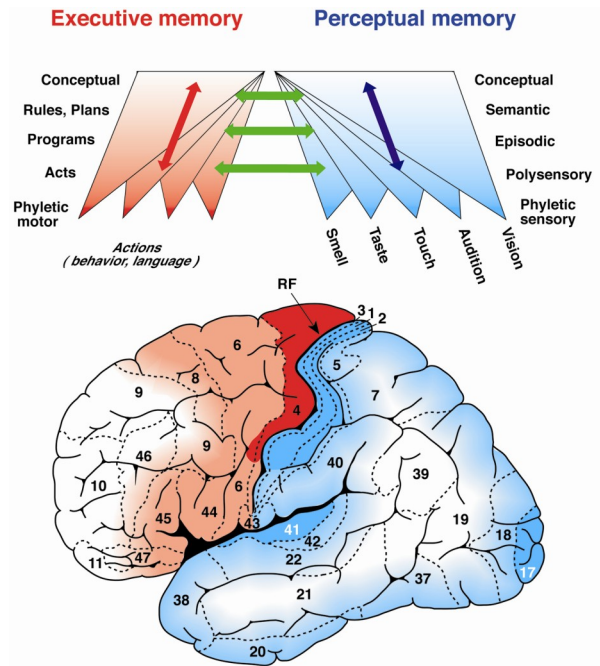


Fig 4. Diagrams of the cortical distribution of perceptual-memory hierarchies (right, blue to white) and executive-memory hierarchies (left, red to white). Numbers in lower diagram designate cytoarchitectonic areas in Brodmann's map. RF, Rolandic Fissure.

In the upper diagram, both the perceptual and the executive hierarchies of cognits are schematically shown to fan upward from sensory or motor phyletic memory. They form and encompass progressively more complex and abstract cognits. That fanning toward higher hierarchical levels marks the progressive increase in the size of cognitive networks, from those representing the memory of simple stimuli and motor acts, in sensory and motor cortex, to the overarching concepts of perceptual and executive knowledge in the highest cortex of association. The overlap of inverted triangles symbolizes the overlap and interactions of cognits of different origin at all hierarchical levels. The thick, bidirectional, red and blue arrows symbolize the reciprocal connectivity across all levels, as well as the existence of “heterarchical” cognits that link neuronal assemblies of different level. Psychologically, one such “heterarchical” cognit would represent, for example, the episodic memory of an event with semantic elements, such as the names of participants in it. The bidirectional green arrows symbolize the connectivity between perceptual and executive hierarchies (anatomically, the axons of the superior longitudinal fasciculus) that form the connective infrastructure of the perception-action cycle (next section).

In the lower diagram, the two sets of hierarchies are projected onto Brodmann's cytoarchitectonic map. It should be emphasized, however, that there

is no one-to-one correspondence between the content of a cognitive network and an anatomically defined area. Many if not most networks extend widely over the cortex, straddling several areas.

Summarizing, Fig. 4 depicts in broad outline the structural organization of cognitive networks that constitute the anatomical foundation of the various forms of memory. However, while presenting a plausible view of the topographic principles of cortical memory allocation, the figure implies somewhat simplistic functional attributes. For example, it suggests that neocortical cognits are exclusively dedicated to memory, whereas in reality they are the functional substrate of all cognitive functions: attention, perception, memory, language and intelligence. Of course, memory intervenes in all of them. However, the evidence from neuropsychology, imaging and physiology is persuasive (Fuster, 2003) that, depending on time and context, all those functions use neocortical cognits of one kind or another. Time and context indeed determine which cognits are selectively and sequentially acti-

vated in the organization of goal-directed behavior or language. The temporal coordination of cognits in environmental context is the essence of the perception-action cycle, which I discuss next.

THE PERCEPTION-ACTION CYCLE

The perception-action (PA) cycle is the circular biocybernetic sequence of neural processes that adjusts the individual to the environment in goal-directed behavior. It is a loop of information processing that runs through motor systems, the environment, perceptual systems, back to motor systems and the environment, and so on in succession until the behavior reaches its goal. The cycle is in its true sense cybernetic (from Gr. κυβερνάω, to steer, navigate, govern) because it regulates actions by use of feedback from the environment, as in the steering of a vessel or in any kind of servomechanism.

The PA cycle has deep biological roots. In lower organisms its precursor is essentially a reflex sen-

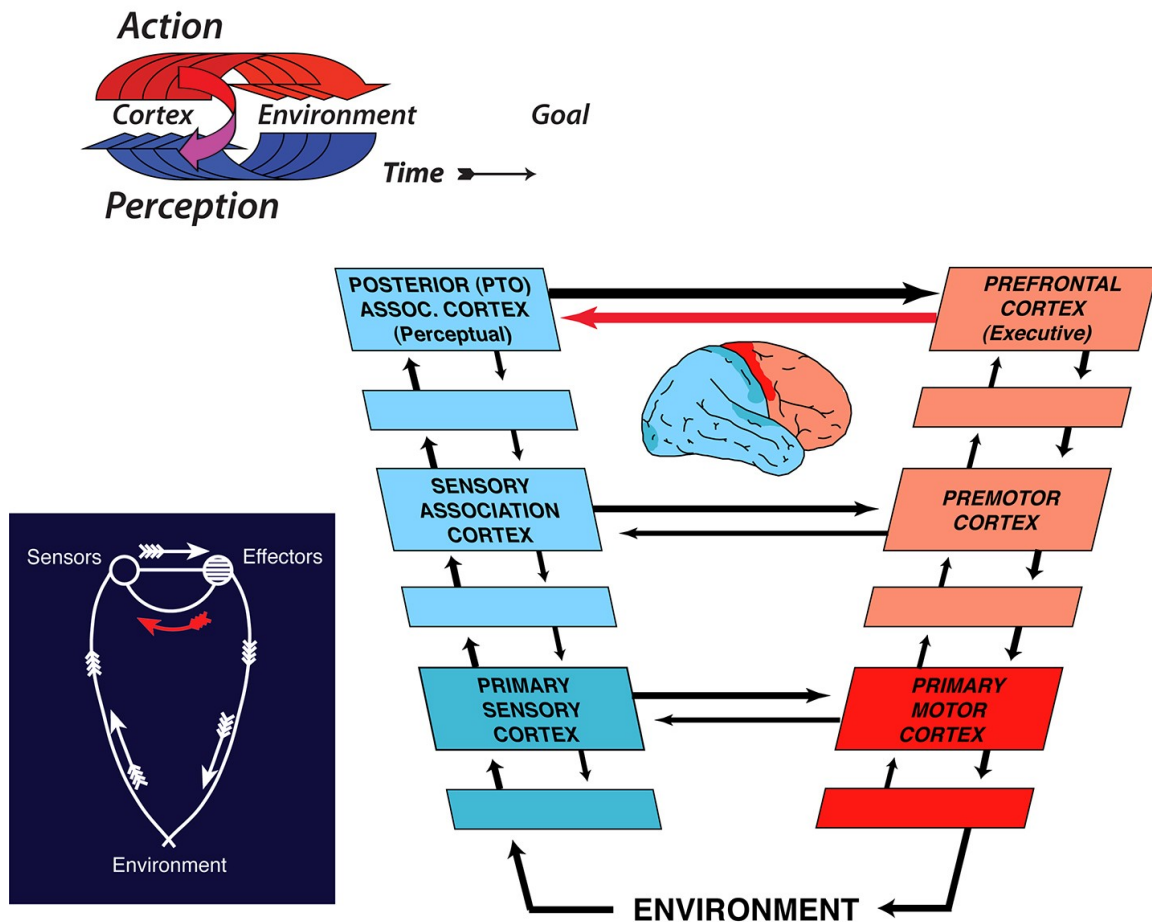


Fig 5. Schematic diagram of the anatomical and functional substrates of the PA cycle. Upper left: Basic dynamics of the PA cycle. Lower right: Cortical circuitry of the cycle. In blue, areas involved in perceptual analysis; in red, areas involved in executive control. (Blank quadrangles represent intermediary areas or sub-areas of those adjacent.) Successive areas in perceptual and executive hierarchies are linked by bidirectional connections; the same is true between areas of comparable rank of the two hierarchies. Red arrow marks internal feedback for executive control functions at the highest hierarchical level (prefrontal cortex). Abbreviation: PTO, parietal-temporal-occipital association cortex. Lower left, Uexküll's reflex cycle in lower animals, the precursor of the PA cycle, with internal feedback from motor to sensory brain (red arrow). In higher animals, that internal feedback will serve cognitive executive control functions (red arrow from prefrontal to posterior cortex in lower right diagram).

sory-motor loop that supports defensive, trophic or procreative functions (Uexküll, 1926). In those organisms, the goal-directed actions are simply reactions to sensory stimuli. In the nervous system of higher animals, Uexküll points out, a new feedback appears, this one internal from effector (motor) to sensory systems, that overrides reflexes and takes a control function over them, anticipating them and preparing the organism for the consequences of its own actions.

Figure 5 portrays, schematically, the cortical regions and connections that constitute the neocortical components of the PA cycle. All neural connections depicted are well substantiated anatomically in the human and nonhuman primate; all are reciprocal, thus symbolized by double arrows. The cortical operations of the PA cycle in behavior could be described in general terms as follows.

A particular PA cycle and the behavior it supports can start anywhere, in the brain or in the environment. It can start by the spontaneous activation of a new mentally conscious or creative cognit, by a visceral stimulus, by an external sensory stimulus or several of them simultaneously, or by any combination of the above. In the course of a goal-directed series of actions, sensory stimuli are processed upward along a perceptual cognitive hierarchy. By association, those stimuli activate cognits previously established in memory. That activation leads to the perceptual categorization of the stimuli in context. That will in turn lead to the structuring of appropriate action for continued adaptation or pursuit of goal; to that effect, the output from perceptual processing will be transmitted to frontal areas, with their executive cognits, for execution of an action. That action will induce change in the environment, which will generate new sensory stimulation, and new percepts, which will lead to corrective actions and/or new actions to guide the organism further to its goal.

Note that the two schematized hierarchies in Fig. 5 are linked at lower cortical levels by bidirectional connections—as they are at the top. These lower linkages represent “short circuits” of the PA cycle that integrate nearly reflex or automatic behavior. This short-circuiting of the cycle—which may operate totally or partly unconsciously—disencumbers higher cortex and frees it for greater flexibility, novelty and complexity. In fact, the short circuits at lower levels form component PA sub-cycles serving the higher PA cycles.

To sum up, the PA cycle constitutes the basic neural infrastructure for the temporal organization of behavior and language. I end this section with an example that illustrates the temporal interlocking of the PA cycles of two conversing persons, each taking the role of the “environment” for the other. Subject A makes a statement that subject B processes through posterior cortical areas, notably Wernicke’s area, for meaning and logic. The output from that processing will flow into B’s frontal

areas, including Broca’s, for response to A’s statement. B’s response will be processed by A’s posterior cortex, which will inform A’s frontal cortex for appropriate reply. The dialogue of the two interlocutors, with their respective PA cycles interlinked, will continue until they reach mutual agreement—or terminate the dialogue for any other reason.

EXECUTIVE FUNCTIONS OF THE PREFRONTAL CORTEX

At the summit of the PA cycle, the cognitive networks of the posterior and prefrontal cortices integrate novel or complex acts of behavior and language (Fuster, 2015). Habitual and simple acts are integrated at lower hierarchical levels, mostly out of consciousness. Especially critical is the intervention of the prefrontal cortex when novel and complex actions need to be concatenated in the time domain for reaching future objectives. In that case, the ability of the prefrontal cortex to create and to carry out goal-directed actions rests on what has been called its “cognitive control” of activity in the posterior association cortex (Miller and Cohen, 2001), with its reservoir of perceptual memory. Without memory, the prefrontal cortex cannot structure the future (Fuster and Bressler, 2015).

On close analysis, “cognitive control”—symbolized in Fig. 5 by a red arrow from prefrontal cortex to posterior association cortex—is a composite of five executive functions: planning, executive attention, working memory, decision-making, and inhibitory control. Before proceeding with their brief description, it should be pointed out that all five functions are prospective, that is, they have an essential future perspective. In fact, one might say that, thanks to those functions, the prefrontal cortex opens the human organism to its future or, conversely, opens the future to the human organism. It is a reasonable conjecture that the human capacities for freedom and creativity, thus to “shape the future,” derive from the extraordinary development of the prefrontal cortex in our species. That development finds its expression not only in the growth of the relative volume of the prefrontal cortex but also, most importantly, in the exponential increase of its intrinsic and extrinsic connectivity, as well as the increment of its cell types. Of critical importance in this respect is the phylogenetic and ontogenetic proliferation of cortical interneurons, which must unquestionably contribute to network expansion and plasticity (Ascoli et al., 2008).

Planning is the most characteristically human of all prefrontal executive functions. It is the ability to form in one’s mind a train of actions leading to a goal. The patient with a sizeable lesion of the anterior-lateral (polar) prefrontal cortex has characteristic difficulties in mentally forming and carrying out plans. His or her life is constrained by what can be

called “temporal concreteness,” encased in routine and without time perspectives, for either past or future. The trouble is so prominent and specific of that kind of lesion that is considered a clinical marker of it. It is rarely if ever observed as a result of other cortical lesions (to be differentiated, however, from apathy and depression). Imaging studies show that thinking of a plan activates the same prefrontal areas that are activated during its enactment (Schacter et al., 2012).

Executive attention—or set—consists in the priming of sensory and motor systems for the performance of an act or a sequence of them in the pursuit of a goal. This preparatory or pre-adaptive function involves sensory and motor systems selectively, and requires excitation as well as inhibition within them. It has long been known (Sherrington, 1906) that the joint reciprocity of excitation and inhibition of different parts of sensory or motor systems serves efficiency and contrast, while optimizing the limited resources of both systems. Within the PA cycle, both sensory and motor attention are predictive and pre-adaptive, in that they anticipate future needs for the attainment of goals and prepare the organism for it. Executive attention, like other executive functions, has its principal cortical base in the lateral prefrontal cortex. From there, in addition to influencing posterior cortex, executive attention controls certain aspects of motility that are essential for attention, such as the movements of the eyes (Brodmann’s area 8).

Working memory is the temporary retention of an item of information for the execution of an act in the short term; it is thus short-term memory with a prospective intention to act in a certain way. That prospective or future aspect is essential to the definition of working memory. The information that this function carries across time can be an activated cognit of long-term memory, or a sensory stimulus of any modality, or the long-term memory activated by that stimulus. Naturally, working memory is necessary for the mediation of cross-temporal contingencies and an essential component of the PA cycle. It is based on the reciprocal activation of the lateral prefrontal cortex and a region of posterior cortex that depends on the modality of the information in temporary storage (Fuster, 2009).

Figure 6 illustrates the activation of infero-temporal and prefrontal cortex of humans during the delay of a delayed-matching task with faces. During that delay or memory period, both areas are activated and engaged in the PA cycle. Working memory invariably activates a prefrontal area in addition to the posterior cortical area in which the perceptual cognit or sensory stimulus to be retained resides or is analyzed.

Psychologically, decision-making is the choice and intention to act in a certain way at a given time and context, thus bringing a PA cycle to closure. The decision critically depends on prior planning,

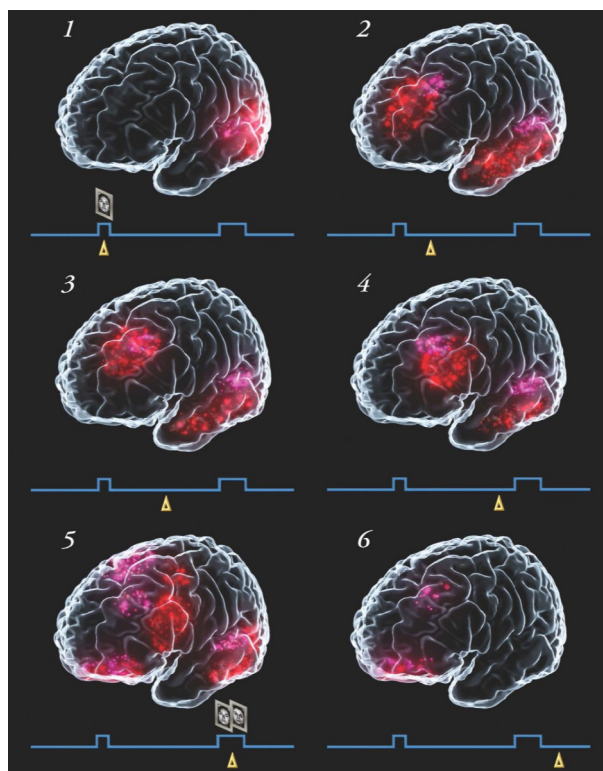


Fig 6. Composite brain-imaging picture from several studies of visual working memory. The series depicted exemplifies the activation (in red) of cortical areas during a trial of a delayed matching-to-sample task with faces. The trial begins with the brief presentation of a face on a screen (1), which the subject must remember through the delay (2-4), at the end of which two faces appear on the screen (5). Then the subject must signal which of the two faces was the sample presented at 1. Note the activation of visual cortex at 1 and 5; also the infero-temporal and prefrontal cortex during the working-memory period (2-4).

executive attention and working memory. Like these other executive functions, decision-making relies on the lateral prefrontal cortex; it also relies on the descending frontal hierarchy to motor cortex and the pyramidal system. However, the input sources to frontal cortex determining a decision, and the PA cycle leading to it, can be not only cortical, but also subcortical—including the thalamus, the basal ganglia, and several structures of the limbic system. Therefore, every behavioral or linguistic decision can be construed as a vector resulting from the frontal confluence, at the time of decision, of many inputs of cortical and subcortical origin, each of them weighted by intensity and probability (Fig. 7). Some of those inputs, from networks of phyletic or individual memory, may be entirely unconscious, yet weigh on decision.

One executive function of the prefrontal cortex, inhibitory control, differs from the others in that it is based predominantly on inhibition instead of excitation. Its critical importance is implied by fact that GABA, the main inhibitory neurotransmitter, is the most abundant of all the inhibitory neurotransmitters identified in the prefrontal cortex (Fuster,

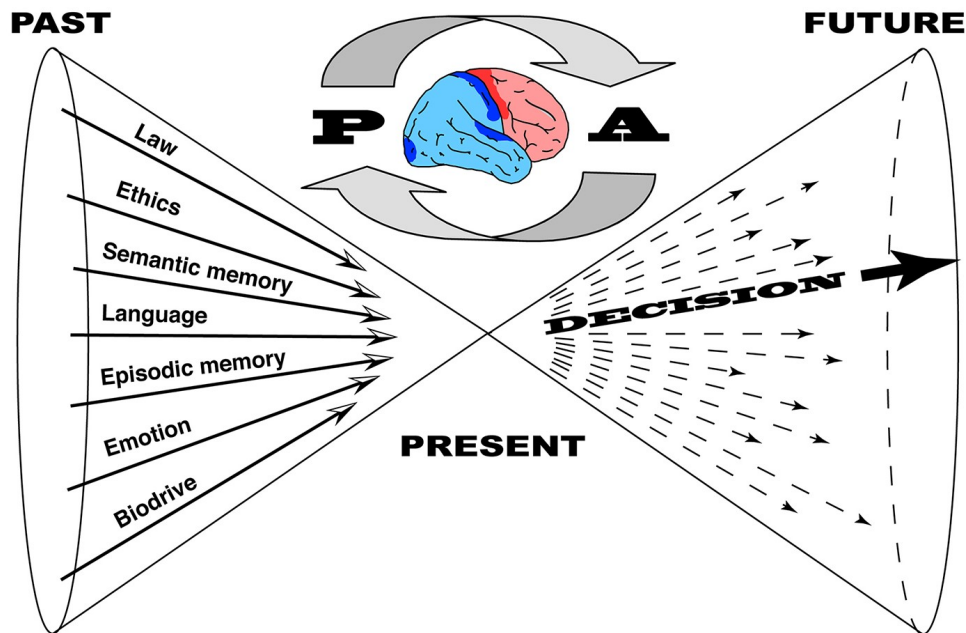


Fig 7. Schematic diagram of the inputs of cognitive or emotional origin that at a given time can influence or determine a decision.

2015). This suggests that inhibition is pervasive throughout this cortex although, according to neuropsychological data, the function of inhibitory control is based primarily in orbitofrontal cortex. On close analysis, however, it appears that the inhibitory control from orbital cortex is principally directed to the restraint of emotional and instinctual impulses—through efferent descending axons to limbic structures. On the other hand, the intrinsic inhibitory control distributed over the lateral prefrontal convexity serves the role of inhibiting cognitive networks and stimuli that conflict with the ones currently active in executive functions. It is reasonable to assume that inhibitory interneurons are essential for the integration of higher cognitive functions, much as they are for the integrative functions of the functions of the spinal cord or the retina, as examples. In any case, inhibitory control serves to protect the PA cycle from interference and, at the same time, to enhance efficiency, saliency and contrast.

The emphasis on executive functions in behavior and language should not obscure the role of the prefrontal cortex and its cognitive networks in creativity, where those functions turn inward to reconfigure memory by creating new artistic forms, new social endeavors, new businesses, or indeed new scientific hypotheses. Undoubtedly, creativity and original thought must involve the recombination of established networks. That requires neuronal and network plasticity, and it is in this light we should read Cajal's words in his *Charlas de Café* (free translation): "Nature has given us a limited endowment of brain cells . . . By happy compensation, it has given us the precious privilege of modifying their connections to combine reflex asso-

ciations almost ad infinitum and to create new ideas" (Cajal, 1966, p.184).

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Fighting with the strong

Antonio Calvo Roy

Science journalist

SUMMARY

From the beginning of his laboratory work, Santiago Ramón y Cajal tried to find his peers among the researchers he read in foreign journals, whom he considered the most important in his field. He was very aware of the importance of publishing the results of his research. The aim of this work is to introduce, chronologically, the evolution of Cajal's works, not only the strictly scientific but also the informational and other material, against the background of the different settings in which he lived and of the so-called "polemic of Spanish science".

Key words: Santiago Ramón y Cajal – Publications – Polemic of Spanish Science – History of Medicine

CAJAL'S SCIENTIFIC PUBLICATIONS: FROM THE BEGINNINGS TO PUBLISHING HIS OWN JOURNALS AND THE HISTOLOGY OF THE NERVOUS SYSTEM OF MAN AND VERTEBRATES

Publishing was always an obsession for Santiago Ramón y Cajal: to make himself understood, to explain himself. He achieved it by publishing his papers in different versions, with additions and amendments, in his *Cuentos de vacaciones*, where he wrote stories that he called pseudoscientific, in his scientific articles in academic language and, in general, sending to the printer everything that flowed from his pen. To leave a trace of his research, to set a precedent and, above all, to pit himself against his peers: this is what encouraged him to publish his research in journals and monographs, on which he spent a large part of his salary.

As early as 1886, when he was a teacher in Valencia, he published his first work in French, and always tried to have his research translated, sometimes even using the translations to make changes, and to insert new things and later work. During his trips, he tried to approach those who could help him to make himself known in other languages, mainly in French and German, meeting his translators whenever he could. At a very early stage, he "was overcome with the itch to export to the foreign market" what he called "the fruit of my enquiries", because "only by fighting with the strong will you become strong".

The first thing that Cajal did when he started researching in Zaragoza, and after his failed military experience, was to publish his results. Those busy years before earning his tenure in Valencia, as he combined different jobs, from being a seller of photographic plates of his own invention to being a teacher, from director of the Anatomical Museum to an assistant and auxiliary of the Medical School, just married and without a clear future, he was concerned to place on record his more than modest research.

His first two essays, published in Zaragoza in 1880 and 1881, "in a separate pamphlet (...) were rather weak". At any rate, those essays marked his trajectory in at least three ways. Firstly, they were both illustrated by Cajal himself, and that was already a hallmark. Besides, because of his shortage of funds, he did it in an "economical" way, so that "I did practical studies in how to use the lithographic pencil and burin. All my publications in Zaragoza and Barcelona (1880 to 1890) had engraved lithographic annexes of my own" (Ramón y Cajal, 1984, p.27).

Secondly, he learns how important is to become known, to be in the world. He complains that his "little novelties [...] as well as everything I sent to the printer in those days, went completely unnoticed by the experts. It could not be otherwise when writing in Spanish, a language unknown by researchers, and publishing timid editions of 100 copies, which that were quickly depleted due to gifts to people not involved in my interests".

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Science journalist

And thirdly, the need to be up to date with what happened in the world of micrography and histology forced him to make “new economic sacrifices” to subscribe, as well as to the two journals he already received— the English *The Quarterly Journal of Microscopical Science* and the French *Journal de micrographie* (Ramon y Cajal, 1952a, p. 240)— to a French journal, the *Journal de l’Anatomie et de la Physiologie*, “that summarized the micrographic achievements of French science”, and another in German, the *Archiv für mikroskopische Anatomie und Entwicklungsgeschichte*, “where the most valuable contributions of German, Russian and Scandinavian histologists and embryologists appeared”.

The three aspects that determined his strategy from then on were publishing, doing so in scientific language, and being aware of what was published outside Spain. Therefore, “I took advantage of the first occasion that I had to collaborate in German journals, then, as today, the most read and authorized”. However, since German was not a language in which he was proficient, he sent to that journal “in a period of two years, two monographs written in mediocre French and illustrated with a profusion of drawings” (Ramón y Cajal, 1984, p. 50). The journal was *Internationale Monatsschrift für Anatomie und Physiologie*, and the article appeared in 1886 and was called *Contribution à l’étude des cellules anastomosées des épithéliums pavimenteux*. The second, published in the same journal in 1888, was *Observations sur la texture des fibres musculaires des pattes et des ailes des insectes*.

He had already published 38 scientific articles up to that year, 1888, his peak year, and he was finishing the instalments that would give rise to his *Manual de Histología normal y técnica micrográfica*, where he included those same articles, as well as some new ones. The first instalment of this *Manual* appeared in May 1884, and it was completed and published by Pascual Aguilar in 1888, with 692 pages, “in small print” and 203 wood engravings. He explains his publication again as “bundling together all my more or less original observations (...), disciplining my overflowing curiosity by adapting it to the rigid frame of a pre-set programme; but also, and above all, the patriotic yearning for an anatomical treatise to come into being in our country that (...) would as far as possible develop its own doctrine.” (Ramón y Cajal, 1984, p. 43). That is, to publish his works in a single volume, to stick with a programme and to be patriotic.

He had also published popular science articles by then, an activity that started in 1883 in the weekly *La Clínica*, with the publication of *Las maravillas de la Histología*. This was followed by *La máquina de la vida*, signed by “El doctor Bacteria”, “a terrible pseudonym, which I used for my philosophical-scientific follies (...) Castelar’s style

without Castelar (...). In these little works I fostered the good intention of drawing the attention of curious doctors to the ineffable charm, almost unknown, of cells and microbes, and of the exceptional importance of their objective and direct study” (Ramón y Cajal, 1984, p. 44).

That desire to be understood made him try to humanize his research, endowing cells with human characteristics and desires in his explanations. In the words of the British researcher Charles Sherrington, Cajal’s host during his visit to England in 1894 and Nobel Prize winner in 1932, “listening to him I wondered to what extent his aptitude to represent the facts in anthropomorphic style would have contributed to his success as a researcher. I never found anyone who possessed this ability to such a high degree” (Cannon, 1951, p. 17).

His huge capacity for work and his scientific production led him to create his own publication, the *Revista Trimestral de Histología*, that first appeared in May 1888 and whose second issue, in August of the same year, had six articles, all of them by Cajal (Fernández Santarén et al., 2007, p. 41); but he also collaborated in the *Gaceta Médica Catalana* and *La Medicina Práctica*. The *Revista* came out “at the cost of no little effort (...) in order to publish the micrographic works of the Medical School Laboratory quickly, without waiting to be received in the editorial department of national and foreign journals (...) The first instalments of that journal were written almost exclusively by its director” (Ramón y Cajal, 1984, p. 191). The third issue of the *Revista* appeared in March 1889 and, “despite these constraints, the ten histologic works published by Cajal in that journal launched a new phase in nervous system research” (López Piñero, 1985, p. 121). Talking about the dissemination of the journal, he declared that “economic reasons obliged me to print a total of not more than 60 copies altogether, aimed almost entirely at foreign academics” (Ramón y Cajal, 2006, p. 404).

This journal was followed, in 1902, now “with official resources”, by the yearbook *Trabajo del Laboratorio de investigaciones biológicas*, which was actually old wine in new bottles and, above all, with different financial backing. It changed its name several times, from the original *Revista Trimestral Micrográfica*, (1896-1900); *Trabajos del Laboratorio de Investigaciones Biológicas de la Universidad de Madrid* (1901-1906); *Travaux du Laboratoire de Recherches Biologiques de l’Université de Madrid* (1907-1908); *Trabajos del Laboratorio de Investigaciones Biológicas de la Universidad de Madrid* (1909-1923); and *Travaux du Laboratoire de Recherches Biologiques de l’Université de Madrid* (1923-1937). Then, after the Civil War, after Cajal’s death, the authorities of the Institute decided that the journal would again lose its name in French and be called *Trabajos del Instituto Cajal de Investigaciones Biológicas* (1940-1979) and *Trabajos del Instituto Cajal* (1980-1987) (Gamundi

et al., 2005, p. 697).

However, feeling that the publication of the articles was not enough, and that he was not taken as seriously as he wanted, Cajal decided to go in person to present his works to the centre of the action, Germany. He openly talks about it in his memoirs: "I was a little alarmed at the silence of the authors to whom I had made a gift of the issues of my journal during the last half of the year 1888 and the first of 1889. Several works I have received this last year about the structure of the nervous system either did not mention me or did so disdainfully, in passing, and without giving any importance to my opinions. The impression that I got from consulting the German journals is that most of the histologists had not read me. The truth is that Spanish is an unknown language for scholars" (Ramón y Cajal, 2006, pp. 428-429).

He decided, therefore, to face the situation, and came up with two strategies that were applied simultaneously: "I called upon two resources to gain the confidence of impartial authors: the first was to translate my main neurological monographs into French, publishing them in the most authoritative German journals; the second consisted of personally showing the wise men my best microscopic specimens and thereby reinforcing the legitimacy of my judgements" (Ramón y Cajal, 2006, p. 431).

Therefore, convinced of the importance of seeing the facts for himself, he left the family with his father, put his specimens into his suitcase, put together "all my small savings" and left for Berlin. He was convinced that close contact breeds affection, because "an excellent tactic is to cultivate friendship and ensure the benevolence of those with whom, due to similarity of tastes, one will have to speak and perhaps contend with in noble and friendly controversy" (Ramón y Cajal, 2006, p.431).

It rarely happens that a specific event, a precise minute, changes everything. In the case of Cajal, it occurred in that congress of the German Anatomical Society, on that day of October 1889, in Berlin. "The most interested of my listeners was A. Kölliker, the venerable patriarch of German Histology. At the end of the session, he took me by carriage to a luxurious hotel where he was staying; invited me to dine; introduced me to the most significant histologists and embryologists in Germany and, in general terms, went out of his way to make my stay as pleasant as possible in the Prussian capital. 'The results obtained by you are so beautiful', he told me, 'that I intend to undertake immediately, adopting your techniques, a series of confirmatory works. I have discovered you, and I want to spread my discovery in Germany'" (Ramón y Cajal, 2006, p. 433).

His strategies achieved the best possible result and, since then, Cajal was able to publish wherever he wanted, and was taken into consideration in every scientific circle under Kölliker's patronage.

"No doubt the truth would have found its way at last. But it was thanks to Kölliker's great authority that my ideas were rapidly spread and appreciated by the academic world".

His key scientific work *Histología del Sistema Nervioso del Hombre y de los Vertebrados*, which has over time become one of the classic works of neuroscience, and of science in general, was first published in Spanish between 1899 and 1904, in five different volumes. "We can get an idea of the amount of work put into it, during the five years the printing lasted, with 1800 pages of text in quarto and 887 original engravings, almost all of them quite large" (Ramón y Cajal, 2006, p. 631). A few years later, between 1909 and 1911, a second edition was published in French, greatly enhanced, so that future Spanish editions incorporated the additions in the French edition entitled *Histologie du système nerveux de l'homme et des vertébrés*, translated by Cajal's friend León Azoulay. It had 925 new original engravings, in black and white and in colour, so "having appeared in 1911, it should be considered as a new work, since I included in it all the results of my research carried out until that date. (...) This work appeared in two thick volumes of almost 1000 pages each" (Ramón y Cajal, 2006, p. 631).

Once again, he explains the reasons for publishing his investigations in Spanish and in other languages, referring to the publication of *Histologie*. "In addition, this book satisfied an understandable and all too human selfishness: fearful of oblivion and not sure of leaving any followers able to assert and defend my modest scientific attainments to strangers, I was determined to gather in an organic whole my neurological memoirs published over fifteen years in national and international journals, as well as to cover with new research the points not dealt with before. But first and foremost, I wanted my book to be –and forgive my pretentiousness– a trophy placed at the feet of our dilapidated national science and an offering of fervent love made by a Spaniard to his undervalued country!" (Ramón y Cajal, 2006, p. 632).

The "undervaluation" mentioned by Cajal may have referred either to Spain or to himself and his fight with the supporters of the reticularist theory. The melancholic idea of the scientific backwardness of Spain, so widespread, may have had its origin in a frequently misquoted sentence, uttered by the histologist. In its best-known form, it says: "the cart of Spanish culture lacks the wheel of science". But what Cajal actually said, specifically in his text of thanks when an effigy of him was erected in the Retiro Park in Madrid on 24 April 1926, was that "the prosperity and power of nations is not only based on military greatness or the flourishing of art and literature, but also on the wealth of scientific ideas, technical conquests and all kinds of useful inventions. With its wheel of Science damaged, the pompous chariot of Hispanic

civilization has lurched along the path of History” (*La Libertad* (Madrid) 25/04/1926, p. 5)

In any case, the old controversy about the scientific backwardness of Spain, to which Cajal contributed with some of his reflections and with this sentence, and above all with this unfortunate analysis, does not seem so pronounced when publications and schools are studied in detail. As opposed to this scenario of an apparent wasteland, Cajal learnt from masters such as Aureliano Maestre de San Juan and Luis Simarro, who were up to date with world science and put it into practice in Spain. Besides, the power of his own histologist school disproves that desolate situation to a certain extent. As José María López Piñero has written at various times in his studies on Spanish Histology (López Piñero, 1973, pp. 9-11; López Piñero et al., 1979; López Piñero et al., 1983), Cajal did not appear out of the blue.

What is clear is that Cajal was a very hard-working genius. Until his death in 1934, the *Revista Trimestral de Histología*, under its various different names, published “395 articles signed by 75 different authors. Among them, there are 10 who stand out and monopolize the greatest part of the publications produced during the period considered. Particularly, 13.3% of the authors publish 69.6% of the articles. Among these 10 authors, Ramón y Cajal stands out exceptionally: by himself he represents 30.1% of the articles published” (Gamundi et al., 2015, p. 697). Truly, it was his own journal, and he was a Stakhanovite of science.

His obsession with publishing is intimately linked with his obsession with excellence. Cajal wants to be, and to have been, present. His contemporary Miguel de Unamuno wrote “when I die /please keep, golden Salamanca of mine/ my memory/ (...)/ tell them I have been”; Cajal also wants everybody to know that he has been. Sometimes he justifies it from the point of view of patriotism. For instance, when he finds no Spanish authors, that is, himself, in foreign studies on Neuroscience, as he wrote in *Charlas de café*: “when we leaf through a new book we can see immediately, if we master the subject, the works that the author has not read. And if among the forgotten ones there are some of ours, the mortification of our self-esteem overshadows our criticism”. At other times, it is the always legitimate ambition that accompanied him throughout his life: “The story of my merits is very simple; it is the most ordinary story of an indomitable will determined to succeed at any cost” (Ramón y Cajal, 1972, pp. 132-133), as he said in his speech of thanks for the tribute paid by the University when he received the Moscow award in 1900.

His last scientific publication, which appeared in the laboratory journal a year before his death, dealt, as might be expected, with the question “Neuronism or reticularism?” It is a summary of an extensive work that had been requested from Ger-

many and whose publication was delayed “too long for an 82-year-old man.” It was his swansong, his last battle against the reticularists to assert, once again, his neuronal theory. “The present booklet, rather than a polemical conflict, which is nearly always pointless, will be the succinct exposition of my observations against the concept of Apathy, Bethe and Held [advocates of the reticular theory]. My purpose is to describe briefly what I have seen [*italics by Cajal*] in over fifty years of work and what any observer, free from academic prejudice, can easily check” (Ramón y Cajal, 1952b, p.1).

With many bibliographical citations of his own works and those of others, and with constant use of the “royal we”, Cajal fights his last battle in writing: it has almost become a personal issue between those who defend the theory that the brain is a single network, the reticularists, and those who maintain that it is a set of independent cells connected to each other, the neuronists. “For us”, he says, with that us that conceals a me, “as well as for the observers of the early period, [...] it is not a matter of a more or less credible theory, but a clear-cut fact” (Ramón y Cajal, 1952b, p. 141). He dedicated almost all his scientific publications to demonstrating that clear-cut fact, although “it would need the advent of the electron microscopy, half a century later, to prove conclusively the morphological individuality of the neuron” (Ramón y Cajal, 2006, p. 313). Cajal was right.

In 1933 he also published, together with Fernando de Castro, *Elementos de Técnica Micrográfica del Sistema Nervioso*. He regretted not having published the third edition of *Textura del Sistema Nervioso del Hombre y los Vertebrados*, for which he had even drawn up the terms of his contract with the publisher (Durán and Alonso, 1983, volume I, p. 385). The manuscript disappeared from his office, either lost or stolen, which, for some authors, hastened his death (Ramón y Cajal, 2006, p. 63).

LITERARY WORK

That impulse to write, to relate, lasted his whole life and became almost more frantic in his last years. From his retirement in 1922, and until his death, in 1934, “he modified almost all his non-scientific books, from *Mi infancia y juventud*, that appeared originally in 1901, to *Historia de mi labor científica*, 1905. He made a first correction, published in 1917, and a definitive edition, in a single volume, in 1923” (Calvo Roy, 1999, p. 209). In addition, he published summaries of his life aimed at children, such as *Cuando yo era niño... La infancia de Ramón y Cajal contada por él mismo*, a remarkable collection of escapades because, as Luis Zulueta says in the prologue, “in those childish things lies the germ of his great discoveries” (Ramón y Cajal, 1921, p. 10).

His memoirs, *Mi infancia y juventud* and *Historia de mi labor científica*, finally collected in a single volume, *Recuerdos de mi vida*, go over his trajectory in detail in a “confession, a work of individual psychology written with great talent” (Ramón y Cajal, 2006, p. 11). It is surprising, by the way, that a critical edition of these memoirs has not yet appeared in Spain. A book that could help us all to put the statements into context, to situate and complete Cajal’s work, to fill gaps and omissions, and provide us conclusively with a means to a deeper knowledge of the figure of Cajal. The restrictions on copyright, which may have been the cause of that anomaly, disappeared in January 2015, the date on which “his works entered the public domain, and anyone could reproduce them, although their authorship and integrity must always be respected, that is to say, they cannot be cut into pieces according to somebody’s will nor, of course, be attributed to any other author” (Calvo Roy, 2014).

Nevertheless, one of his works stands out among all as being that which has had more editions and has been translated into several languages since Cajal authorized translations; because in the early years he decided to save it “for Spaniards who, in his opinion, were its exclusive addressees” (Ramón y Cajal, 2006, p. 13). This is *Reglas y consejos sobre investigación científica* (*Los tónicos de la voluntad*), published for the first time in 1898. It is an amended and enlarged version of his speech given on 5 December 1897, when he joined the *Academia de Ciencias Exactas Físicas y Naturales*, with the title *Fundamentos racionales y condiciones técnicas de la investigación biológica*. Cajal arranged for it to be given, at the expense of his estate, to the best students in the Medicine School. Today we can download it for free from the CSIC Website. (http://libros.csic.es/product_info.php?products_id=533).

Given the good reception that that speech had, Dr Lluria published it at his expense in 1898, under the title *Reglas y consejos sobre la investigación biológica*. The new title better reflected Cajal’s feelings when he wrote his speech: to serve as scientific and methodological guidance for Spanish university youth. Cajal added an interesting ‘Prologue’ and a rather pessimistic ‘Post-scriptum’. Both bear the date of 20 December 1899. The speech was distributed free of charge among university students throughout Spain. In the year 1912, a new edition of Cajal’s speech appeared, the third, but enlarged and with a new subtitle: *Reglas y consejos sobre investigación científica (Los tónicos de la voluntad)* (Ayala Martínez, 1998, p. 33). Since then it has kept that title and been published dozens of times, fulfilling Cajal’s wish to make it accessible to young researchers.

It is a series of thoughts on science and research, “suggestions explained with fervour and enthusiasm, perhaps a little exaggerated and na-

ive, [that] will be positively useful in order to train researchers” (Ramón y Cajal, 1999, p. 11), according to Cajal himself in the prologue of the second edition, the one paid for by Lluria. In the epilogue of that same edition, tinged with the pessimism that invaded Cajal after the 1898 Disaster, there is one more reason to publish as much as possible: “Let every foreign book in which you do not see Spanish names quoted, be a sting that pierces your soul and excites your thirst for knowledge and originality!” (Ramón y Cajal, 1999, p. 202).

Charlas de café, originally published in 1920 under the title *Chácharas de café*, was revised again and obtained remarkable success; the fourth edition appeared in 1932. It is, after his memoirs, his third literary work, a collection of more or less witty thoughts and phrases that had a greater impact than he expected, so he insisted in successive prologues that it consisted of “fantasies and digressions, without intending to establish a doctrine” (Ramón y Cajal, 2006, p. 13-14).

His last book, *El mundo visto a los ochenta años* (*Impresiones de un arteriosclerótico*), appeared very shortly before his death. It is a remarkable self-portrait of his old age in which he gives free rein to his criticism of the world of that time, possessed by “the dangerous mania of our times”, which is “the delirium of speed”, and which is manifested in locomotives, automobiles and “homicidal aeroplanes”, that “audacious and reckless in war, are almost as fearsome in peace.” In short, “haunted by the demon of speed, life has lost much value.” He talks about the diseases of old age, prevailing bad taste, the Anglicisms and Gallisms that corrupt the language, and criticizes all and sundry. Reading it 85 years later it seems a great mixture of humour and diverse profound reflections from someone who sees his end very near, which makes him ill-tempered.

However, he did not especially cultivate collaboration with newspapers, except in the years after the 1898 Disaster, although he did do so with literature, whose discovery he describes in his memoirs, in a rather novelettish way. At 12 years old, banished to the attic to study, he found in another nearby attic *The Three Musketeers* and *The Count of Montecristo*, as well as the works of Quevedo, Calderón, Victor Hugo and Lamartine. Perhaps because of their shared solitude, he affirms that *Robinson Crusoe* was one of the novels that impressed him the most at the time. With age, he opted for the Latin classics, one of his many hobbies.

To his literary work, as well as the four mentioned above, should be added *Cuentos de vacaciones: Narraciones pseudocientíficas*, which contains five stories of the dozen he claims to have written. On the cover of the first edition, “First series” appears under the corresponding title, which seems to announce a second that was never published. These are “stories that pose social or moral

dilemmas of difficult solution motivated by the advances of science or by the incorrect scientific education of the people. Cajal intended to improve that education and banish false beliefs and superstitions" (Collado and Carrillo, 2018, p. 39). In addition to these five, "Nana Ramón y Cajal, granddaughter of the histologist, and her husband García Durán rescued one of the tales that was never published, entitled *La vida en el año 6000*, in which the author shows some skill at predictions regarding scientific progress" (Collado and Carrillo, 2018, p. 43).

In all of them he clearly shows his faith in science, capable of solving any problem, exacting better revenge, solving agricultural difficulties, as long, of course, as the microscope is used adequately. It is, according to the author, "a collection of twelve fables or semi-philosophical and pseudo-scientific stories that I did not dare to send to the printer's, not only because of the quirky ideas but also because of the weakness and slovenliness of the style" (Ramón y Cajal, 1964, p. 7).

He also left a written record of his other passions, which he cultivated at various times and with different intensity, especially of photography, perhaps his most durable passion, that he developed longest and with most zeal. *La fotografía de los colores*, published in 1912 with the aim of "initiating or encouraging the noble inclination to heliochromy in our youth" (Ramón y Cajal, 1994, p. 7), is a splendid detailed manual, and one of the first to appear on this speciality in Spain. "In the historical panorama of Spanish photographic bibliography", Gerardo Kurzt points out, "this book stands out on its own, providing a fundamental basis for a historical understanding of everything related to colour photography in the years when this technique, as a practical and feasible medium, was in its infancy. Santiago Ramón y Cajal constructs a book that is a genuine compendium of the technical state of this photographic reality in 1912" (Ramón y Cajal, 1994, p. XII). And, again, he is driven by the fact that "we lack works of this nature in Spain, and we judge that the advice of a veteran cultivator of almost all heliochromic types will not be superfluous" (Ramón y Cajal, 1994, p. 6).

There is no record that he left any specific texts of his other passions, chess and astronomy, although they were more ephemeral.

Shortly before his death, Cajal was working on several manuscripts, apart from *El mundo visto a los ochenta años*. He also intended to write a study on *Alucinaciones y ensueños*, that he never finished and whose manuscript was lost in the Civil War (Ibarz Serrat, 2017, p. 25).

Nor did he get round to publishing old projects which appeared and disappeared from his list of tasks, "some philosophical books that I have cobbled together [in which] I will perhaps be inclined to uphold more than one risky thesis, bordering

Scepticism and exaggerated Nominalism, or critical Positivism, or Evolutionism, perhaps interpreted in a new way. Between occasionally going off the rails, and going too far or not far enough, which is what happens in Spain, the choice is not in doubt", he writes in a letter to a friend dated in 1913. And he continues: "If after 25 years of passionately studying the organ of thought in man and animals, I have not yet earned the right to reason with some independence about these philosophical questions, intimately related to my own discoveries, then I have made a fool of myself! It would be good if we still had to emigrate to write in the 20th century and renounce the Spanish language and Spaniards!"

At some point, according to Cajal's confession in *El mundo visto a los ochenta años*, he also thought about writing about death, in a book called *Solos ante el misterio*, about histo-psychological criteria applied to the formation of personality, and another on *Omnipotencia de la sugestión*, about which he did write an article. "I have also written, but I do not know if I will succeed in publishing, a book on Hypnotism, Spiritualism and Parapsychology, that should have seen the light twenty years ago. Today it would not be interesting" (Ramón y Cajal, 1934, p. 218).

This is ultimately a researcher who considers that the popular adage publish or perish, coined in the decade of the 20s of the last century (Gardfield, 1996), only made sense if you consider that it is almost worse to publish and then not be read. Cajal was determined to publish, and was lucky enough to be read. His impressive complete bibliography can be consulted on several Internet websites (for instance: (<http://www.patologia.es/volumen35/vol35-num4/35-4n12.htm>), and also, greatly expanded with texts about him and 2.338 references, on (<http://www.casaubieta.com/blog/bibliografia-interactiva-sobre-los-ramon-y-cajal/>).

What it is now urgently needed is to take seriously the project of publishing his major works, above all *Recuerdos de mi vida* and *Reglas y Consejos*, in critical annotated editions, and with a little more time for the others. It makes no sense at all that we do not have them, and that someone of the scientific standing of Cajal does not have a critical edition of his works. Let us hope that, at least for 2023, if not sooner, when the centenary of the publication of *Recuerdos de mi vida* is celebrated, that unbearable gap will be filled.

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The early drawings and prints of Santiago Ramón y Cajal: a visual epistemology of the neurosciences

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SUMMARY

Santiago Ramón y Cajal created histological images using a variety of artistic techniques and methods. In order to contextualise his practice, I have selected a set of drawings and prints of cartilage cells that were used in Cajal's reference handbooks. I then introduce a lithograph representing an inflamed cartilage included in Cajal's first publication. This technique enabled the publishing of graphic information in colour. By reviewing images included in the material that Cajal consulted during his pre-graduate years, I show that he participated in the transnational production of drawing and made use of the printing techniques available to present his research.

By analysing a set of original drawings included in Cajal's notebook, *Diario de Observaciones*, and his first published lithographs of cartilage cells and neurons, I reveal the graphic specificities of his transition from handmade drawings to print representations. Cajal's drawing and lithographing relate directly to artistic interests developed in his youth (López Piñero, 1985), and these skills facilitated the technical transit between notebook and published images, enabling him to formalise his knowledge by including histological results in printed material. A determining factor in Cajal's graphic production relating to the nervous system was his expertise in using chemical silver nitrate, resulting from his interest in photography. Finally, his colour selection is discussed, in order to demonstrate

that, even when Cajal drew black lines, he was using black as a specific colour, one he observed through the microscope after staining histological samples.

Key words: Visual epistemology – Santiago Ramón y Cajal – Representation – Drawings – Neurohistology – Pathology – Notebook

INTRODUCTION

This essay explores the visual epistemology of Santiago Ramón y Cajal (1852-1934). Celebrated as an innovative and pioneering researcher in the neurosciences and as an artist by historians of medicine and contemporary neuroscientists alike, an exhibition touring the US has recently contributed to Cajal's renown as an artist-scientist (<http://wam.umn.edu/calendar/cajal/>, 2017). This paper focuses on the techniques and skills he used to produce images. I regard these practices as the core of his production of histological knowledge. Many authors have studied Ramón y Cajal as a photographer (Márquez, 2004), and as a drawing artist (de Carlos, 2006; Esteban, 2003; García et al., 2003; García and de Felipe, 2005). My aim is to analyse his graphic representations as the products of a researcher skilled in many artistic disciplines. I suggest that he selected the image printing techniques himself, from a range of possibili-

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ties, and that this selection was a major part of the innovative contributions he made to our understanding of the nervous system.

Through analysis of his early works – the prints included in two publications, one in 1880, the other in 1888, and a selection of drawings of cartilage cells included in his first notebook – this essay contextualises Cajal's practices in a transnational environment of graphic histological production¹.

I argue that a process of image creation is at the core of Cajal's histological knowledge production. For his early publications Cajal sketched preparatory drawings, which he later traced onto lithographic stone. Other artists, such as Francisco de Goya, had participated in the entire process from drawing to lithograph printing (Harris 1964), but artists have often relied on professional engravers to reproduce their work in print, as Raphael did with Marcantonio Raimondi (Griffiths 1980: 46-47). In order to publish their own drawings, scientists have required the expertise and skills of professional illustrators and engravers (Kusukawa 2012: 145), and in this paper I suggest that the combination of Cajal's drawing and printing strategies was a key factor in his visual epistemology.

In the first part, I describe a lithograph of a cartilage made by Cajal, and demonstrate its similarity to six printed images included in the handbooks he consulted as a medical student. I contextualise Cajal's prints of inflamed cartilages at a time when the use of lithography in pathological graphic representation was increasing. Lithography has particular features relating to colour, and a shorter production time than other techniques available at that time. In the second part, I present Cajal's pencil and ink drawings of an inflamed cartilage in one of his personal notebooks, which he later published as lithographs with some modifications. Cajal's artistic skills interacted between his original works² and printed images, enabling him to publish and thus distribute his histological contributions.

In a third part, I introduce Cajal's notebook drawings and printed representations of the nervous system, and demonstrate that his use of the colour black in the images he included in publications from 1888 was intentional and significant. The drawing features and printed characteristics of his representations of the neuron differ from those of the cartilage cells, and I discuss the decisions Cajal made relating to these formats and study objects. I suggest Cajal's graphic production belongs to a culture to which he was introduced in his early

days as a histologist.

SHAPING CARTILAGES

The printing techniques available in each time and place have determined the form of graphic representation in histology and anatomy. Various techniques coexisted in the transnational graphic production of cell shapes during the 19th century (López Piñero, 1999; Griffiths, 1980), at least two of which were used by Santiago Ramón y Cajal to represent cartilage cells in his first publication and in a number of the treatises circulated during Cajal's years as a medical student. According to his memoirs, Cajal consulted *Die Cellularpathologie* by Rudolf Virchow (1858) as a student, at a time when Virchow was playing a major role in establishing cell theory, and, among other handbooks, a histological treatise by Rudolf Albert von Kölliker (1852)³.

A set of images of cartilage cells published between 1851 and 1880 which helped construct histological and pathological knowledge at that time reveal a transnational network of knowledge and practices produced by histologists. This was certainly the case for representations of neurons, as Golgi and Cajal used similar shapes to depict brain tissues (see Figs. 1 and 2)⁴.

According to de Felipe (2014), although Cajal

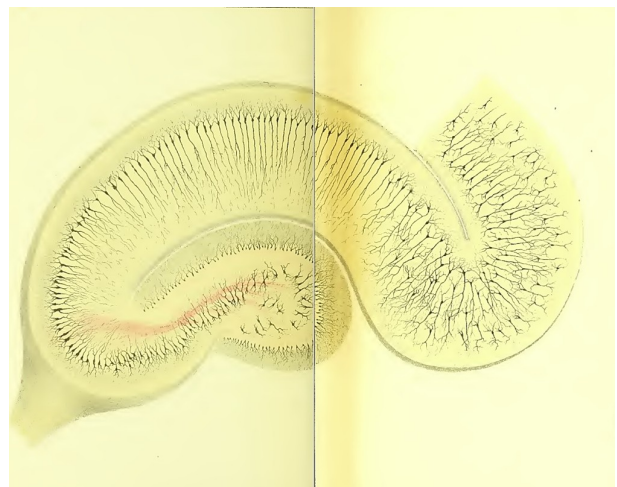


Fig 1. Golgi, Camilo (1886) *Sulla fina anatomia degli organi centrali del sistema nervoso*. Fig. 20, p 340. Lithography. Vertical section of the hippocampus in a newborn cat. Red represents a nervous set. There is a yellowish background with the reticular mass of cells represented in black with some areas shaded grey and red coloured lines.

¹Older notebooks exist but these are more artistically oriented. "During his period in Cuba he continued painting, because from this period there is a small notebook kept in the Legado Cajal containing a watercolour drawing, four diluted pastel and five graphite sketches" (De Carlos, Juan A, 2006: 150). Later notebooks can be found at the Legado Cajal of the Instituto Cajal.

²By original works I refer to a pre-reproducible stage of a representation, as used by Walter Benjamin (2003).

³I read *Allgemeine Anatomie* by Henle [1843], and the classic *Treatise on Histologie and Iysoquimi* by Frey [1871], Van Kempen [1851] and Robin [1871], excellent French books, also served me as guides. For the practical work I could consult *The Microscope in Medicine*, by Beale [1854], *Protoplasm, or, life, matter and mind* and the well-known *Manuel de technique*, by Latteux [1883]. As for scientific journals, the shortage of Money forced me to subscribe to some English Archives [*The Quarterly Microscopical Science*] and a French monthly journal, directed by E. Pelletan [*Journal de micrographie*] (Ramón y Cajal, 1917. Pg.5). I have provided the year of publication of the first edition of each volume and the name of the journal in square brackets.

⁴See Golgi 1886; the revision of Golgi's visual epistemology in Daston and Galison 2007, chapter Three; also de Felipe 2014.

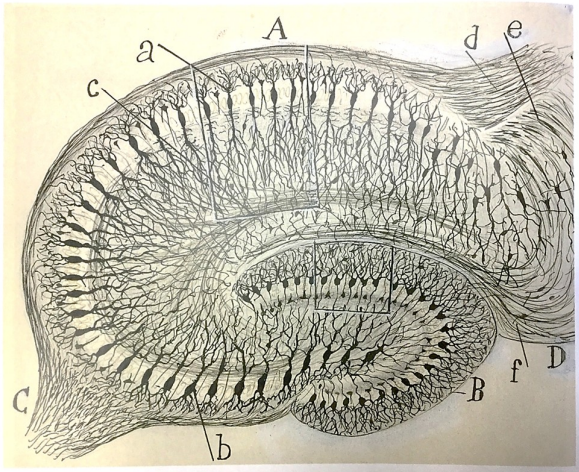


Fig 2. Ramón y Cajal, Santiago (1917) *Recuerdos de mi vida*. Vol. 2. Fig. 41, p 250. Photoengraving. The principal neuronal types are represented following the description by Golgi and Sala.

used the same shapes to represent the nervous system as his contemporaries, conceptual differences can be noted in the details. It is the production of similar histological shapes that I will address here. To demonstrate Cajal's participation in the transnational circulation of cell and tissue images, I have selected six images from contemporary handbooks produced by scientists from across Europe: Dutch anatomist Etienne M. van Kempen, German pathologist Rudolf Virchow, Swiss anatomist Rudolf A. von Kölliker, German entomologist Heinrich Frey, and the Spanish medical doctors, Eduardo García Solá and Aureliano Maestre de San Juan.

The absence of colour in these six images could be regarded as deliberate. Printing options without colour included, among others, stipple engraving,

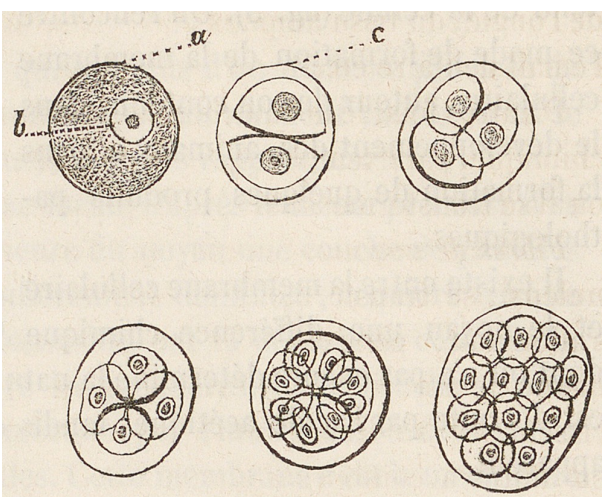


Fig 3. Van Kempen, Etienne Michel (1851). *Manuel D'anatomie Générale*. France: Imprimeurs-Libraires de l'Université, p 24. Available at Google Books: <https://books.google.es/books?id=xIRAAAAcAAJ&printsec=frontcover&hl=es#v=onepage&q&f=false>. Accessed on 28th May, 2018.

shadowed images and the inclusion of text. These strategies provided scientific images with a characteristic shape, and thus a specific way of presenting knowledge for a particular, specialised audience: medical students and doctors.

Most of these monochrome pictures were produced through wood engraving, cutting away wood to leave the representation in relief. A particular form of woodcut developed during the 18th century, wood engraving utilised a harder wood and a burin to engrave across the grain. Histological and anatomical images could be published in inserted leafs or within the text (Gaskell, 2004).

The replication of images through the reuse of woodblocks – both authorised and unauthorised – became widespread in the 16th century. Engraving became more popular due to its better capturing of details, the increasing engraving skills of woodblock cutters, and the expanding production and market for prints during the final part of the 16th century (Kusukawa, 2012: 29-37, 64). With its highly detailed results, wood-engraving became

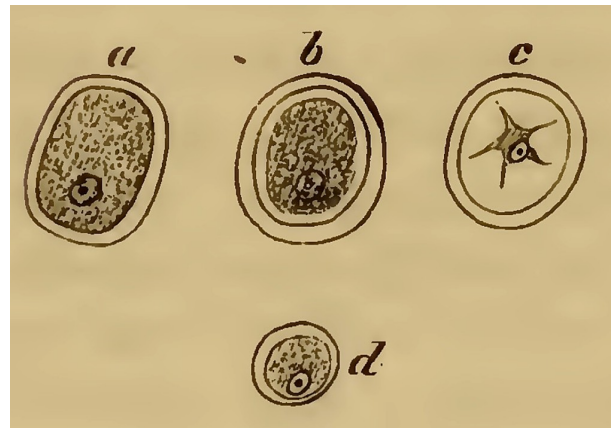


Fig 4. Virchow, Rudolf (1859). *Die Cellularpathologie*. Berlin: Verlag von August Hirschwald, p 6. Available at Archive.org: <https://archive.org/details/diecellularpatho00virc> Accessed on 28th May, 2018.

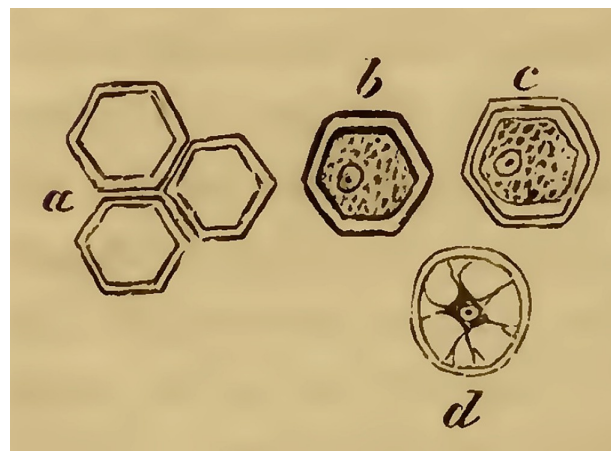


Fig 5. Virchow, Rudolf (1859). *Die Cellularpathologie*. Berlin: Verlag von August Hirschwald, pg.4. Available at Archive.org: <https://archive.org/details/diecellularpatho00virc> Accessed on 28th May, 2018.

widely used, especially after 1830 (Griffith, 1980: 24).

Professor Etienne M. van Kempen of the Katholieke Universiteit in Leuven (1814-1893), included a set of wood-engraving prints in his *Manuel d'anatomie générale* (1851), six of these representing cartilaginous cells (Fig. 3). The images exhibit the multiplication of cells through nuclear division in embryonic and cancerous tissue (van Kempen, 1851: 24). The first image on the left has an additional element: stipple engraving. This technique is used to differentiate, emphasise and

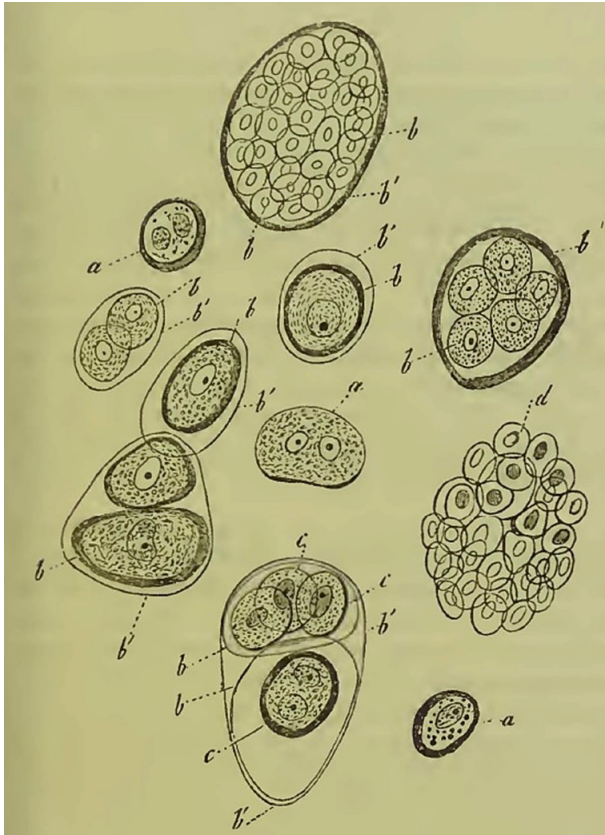


Fig 6. Rudolf Kölliker (1852). *Handbuch der Gewebelehre des Menschen*. Leipzig: Verlag von Wilhelm Engelmann, pg 19. Woodcut. Available at: http://reader.digitale-sammlungen.de/de/fs1/object/display/bsb10368714_00035.html. Accessed on 28th May, 2018.

shade parts of an image. Invented in England during the second half of the 18th century, stipple was used as a stand-alone technique at the start of the 19th century, but was more commonly combined with other methods and strategies, such as hatching and crosshatching (López Piñero, 1999: 70). The first cell on the left of Figure 3 displays the successive stages of cell division.

In the wood engravings from *Die Cellularpathologie* (1858), German pathologist Rudolf Virchow (1821-1902) depicted a set of cells from the ossification border of a growing cartilage (Fig. 4). Virchow explained how the vegetal cell (Fig. 5) had been used by the naturalist Theodor Schwann

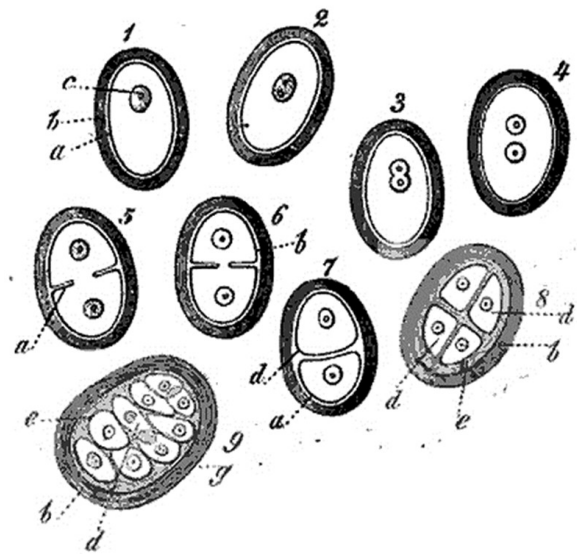


Fig 7. Frey, Heinrich (1871). *Traité d'histologie et d'histochimie*. Paris: F. Savy, p 198. Available at: <https://play.google.com/books/reader?id=EcF8SeghIAsC&printsec=frontcover&output=reader&hl=es&pg=GBS.PA198> Accessed on 29th May, 2018.

(1810-1882) to study the animal cell, emphasising that the vegetal cell was formed by a Membran (membrane) and a nucleus. In both vegetal and animal cell images Virchow highlighted the äussere Schicht (outer layer) with a zarte Haut (thin layer) when showing the Inhalt (content) and the Kern (nucleus). The printed images combine stipple engraving with shade and diagonal lines.

Rudolf Kölliker (1817-1905) produced more complex images of human cartilaginous cells (Fig. 6). His wood engraving depicts cells with and without membranes, their nuclei, successive generation of

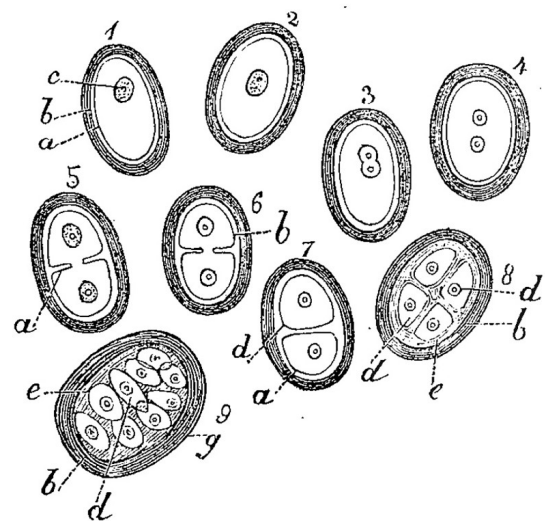


Fig 8. Maestre de San Juan, Aureliano (1880). *Tratado elemental de histología normal y patológica*, Fig. 49, p 183. This engraving is similar to figure 7, the main difference being the position of letters and numbers. The parts of Frey's image that were shaded are represented here with lines.

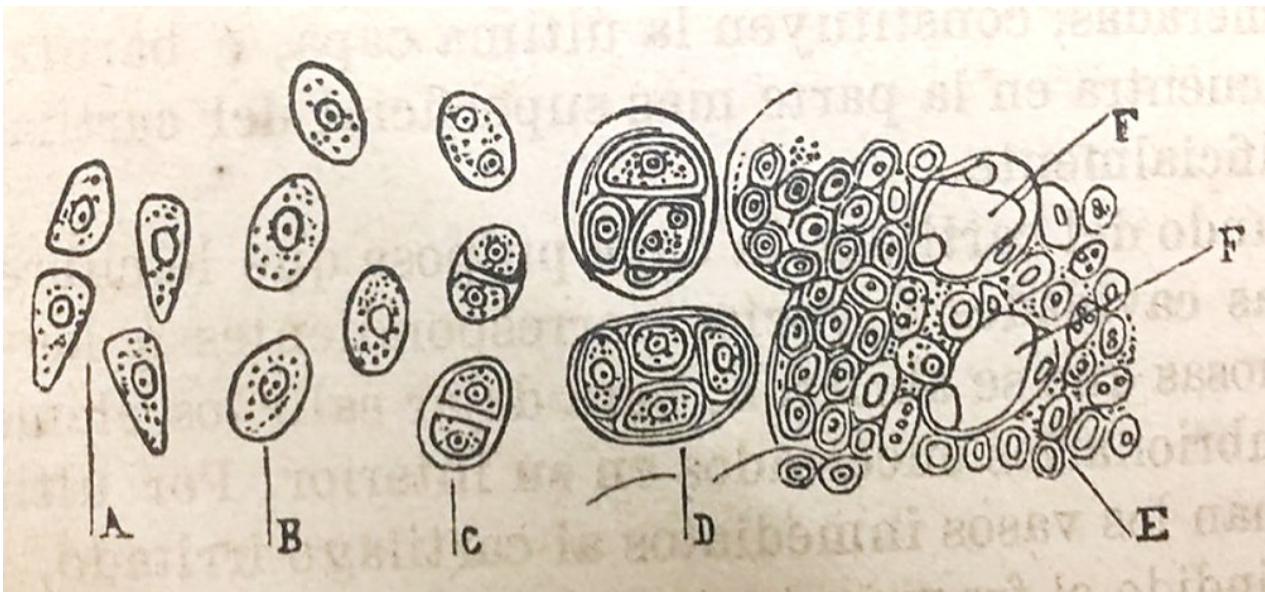


Fig 9. Eduardo García Solá (1877). *Tratado de Patología y Anatomía Patológica*, p 610. Second edition available at: <http://bdh-rd.bne.es/viewer.vm?id=0000010062&page=1>. Accessed on 1st June, 2018.

cells with one or two nuclei, second-generation cells (from one to three cells) and daughter cell groups among other elements marked with letters (Kölliker, 1852: 19). Kölliker, or his engraver, used similar methods to Virchow, but incorporated a diversity of tonalities by hatching with a single ink to differentiate cell parts.

In his *Traité d'histologie et d'histochimie* (1870), the German-born Swiss entomologist Heinrich Frey (1822-1890) also used wood engraving to portray cartilage cell division (Fig. 7). Frey used letters to differentiate the inner parts of the cell, capsules (capsules), noyau (nucleus), cellules endogènes (endogenous cells), capsules secondaires formées à la surface des cellules (secondary capsules formed on the outer layer of cells) and the couche externe de la capsule confondue avec la substance fondamentale (outer layer of the cell merged with the fundamental substance) (Frey 1871: 198). Frey's strategy for formalising the shape of the object consists of emphasising specific areas by filling through lineal hatching with ink.

Aureliano Maestre de San Juan (1828-1890) was a Spanish histologist at the University of Madrid Medical School, where he supervised Cajal's thesis (López Piñero, 2000: 56). Apart from the position and size of the letters, this picture (Figure 8), included in his *Tratado elemental de histología normal y patológica* (1879), is almost identical to Frey's (compare Figs. 8 and 7), demonstrating that this treatise is composed of previously used images. Maestre de San Juan, or his illustrator, may have used Heinrich Frey's image as part of the large-scale repetition and modification of previously published shapes, thereby validating and normalising these forms (Hoopwood, 2015; Jimenez, 2004).

Eduardo García Solá (1845-1922), also Aureliano Maestre de San Juan's student but at the University of Granada Medical School (López Piñero, 1985: 56), published his *Tratado de patología general y anatomía patológica* in 1874. The treatise would be widely used in Spanish universities throughout the late 19th century. The picture I have selected (Fig. 9) shows a section from an artificially inflamed cartilage. This image was represented five years later in Aureliano Maestre de San Juan's *Tratado elemental de histología normal y patológica* (1879). Solá and San Juan's handbooks were published by the same printer: Nicolás Moyá Editores. The similarities between these images suggest that the printer used the same woodblocks and metal plates for both treatises, a practice that appears to have endured until at least the early 20th century (Kusukawa, 2012: 64).

The picture also shows cartilage cells in a normal state, some with a larger protoplasm and nucleus. The image illustrates that when tissue is irritated, the nucleus divides repeatedly producing a multitude of cells (García Solá, 1877: 610). A variety of cell sizes and cell membrane thicknesses are included to depict the process of inflammation. The stipple engraving technique is used here to show the inner part of the cell.

These graphic forms of cartilage appeared in many handbooks viewed by anatomists and histologists from diverse European medical schools. Cajal participated in this visual culture from his early days as a histological researcher, long before his focus shifted to neurons.

LITHOGRAPHY AND COLOURED PATHOLOGIES

Under Maestre de San Juan's supervision, Santiago Ramón y Cajal presented his doctoral thesis

on the cartilage and its reaction to inflammation at the University of Madrid Medical School in 1877 (López Piñero, 1985: 63-65). Cajal was introduced to histological and cytological drawing as an experimental – scientific – skill through Maestre de San Juan's graduate teaching (López Piñero, 1985: 65). However, his training and experience in drawing and photographing took place earlier in life – Cajal drew as a child and discovered photography in his teenage years (Ramón y Cajal, 1917) – so when faced with the need to depict the cartilage he was skilled and prepared (Esteban, 2003; Márquez, 2004; García y de Felipe, 2005; de Carlos, 2006). Cajal presented part of these studies of inflamed cartilage cells in his first publication, 'Investigaciones experimentales sobre la inflamación en el mesenterio, la córnea y el cartílago' (Experimental investigations on inflammation in the mesentery, cornea and cartilage). Nine separately produced lithograph prints on two pages were included. I have selected one of these images published in 1880 to illustrate the influence that contemporary images of the cell had on Cajal's work (see Fig. 10).

Although in later treatises Cajal relied on engravers to transform his original drawings into printed material (Ramón y Cajal, 1889; López Piñero,



Fig 10. Ramón y Cajal, Santiago (1880). *Investigaciones experimentales sobre la génesis inflamatoria*. Zaragoza: *El Diario Católico*. Pg. 62. Detail of lithograph. The cells are lined in red during lithography, shadowed in their inner part in washed carmine and emphasised with other lines coloured by hand.

1999: 299), "due to the lack of resources to pay for an artist" he created the lithograph for this first publication himself (Ramón y Cajal, 1917: 29). Cajal repeated and verified experiments by the pathologist Julius Cohnheim (1839-1884) on inflammation, the subject of his own PhD thesis (López Piñero, 1985: 64; Rodríguez Quiroga, 2002: 132). While his initial observations were based on reviewing and repeating other theories, in his second publication Cajal included his own innovative observations (Ramón y Cajal, 1881; López Piñero, 1985: 77-79).

Cajal's 1880 publication was produced at a time when printing techniques were being revitalised by the expansion of lithography, introduced to Spain by José María Cardano (1781-1835). Cardano had worked in Munich with Alois Senefelder, who invented the technique in 1798 (Griffiths, 1980: 105). On returning to Spain in 1818, Cardano settled in Madrid and founded the first institution dedicated to the use of lithography: *Establecimiento Litográfico del Depósito Hidrográfico de Madrid* (Vega, 1990).

Lithography consists of tracing a drawing with greasy, oil or wax on limestone, then using a nitrated acid solution and gum arabic to etch away ungreased parts of the stone. Water is added, which, due to the immiscibility of water and oil, is repelled from the traced area. An oil-based ink can then be applied to make the print. Lithographic copies retain all details perfectly (López Piñero, 1999: 252).

In histopathological drawing studies, the introduction of colour became a highly instrumental feature, as tissues stained in a particular way were associated with particular pathologies. By the 19th century, the use of colour lithography had substantially increased the precision of images and demonstrated the changing pathological anatomy of tissues over time (Bertolini, 2015). Influential works included *Anatomie pathologique* (1829-1842) by Jean Cruveilhier (1791-1874), regarded as "the first treatise on the diseases of the entire human body based on recent postmortems and illustrated in color" (Bertolini, 2015: 209). Following advice from his father, Cajal had consulted the four volumes of Cruveilhier's *Traité de anatomie descriptive* (1834-1836) as medical student in Zaragoza (López Piñero, 2006: 124). Both Cruveilhier's works included lithographs.

Laboratory staining techniques used to make tissue structures visible also influenced the production of images by drawing. Through a use of colour, Cajal was able to show the development of cartilage inflammation by using a particular staining method to clearly distinguish cells and the process of division. Cajal noted in his 1880 publication that to this end he used, among other substances, silver impregnation, colouring with picocarminate and fixing with hyposulfite of soda; that is, chemical solutions that alter the colour of tissue, making it visible under the microscope (Ramón y Cajal,



Fig 11. Diario de Observaciones S.R.C. (Madrid, Legado Cajal, legajo 1.511). Unless otherwise stated, every notebook picture has been taken by the author and reproduced with permission.

1880). Lithography enabled the use of various colour layers to highlight, shade and differentiate elements in an image.

As lithographic printing required a particular type of paper, lithographs were often printed on a different paper than the text; a diversity of paper in a publication was precisely due to the fact that images and texts were printed by different professionals (Gaskell, 2004: 225). As a visual account of

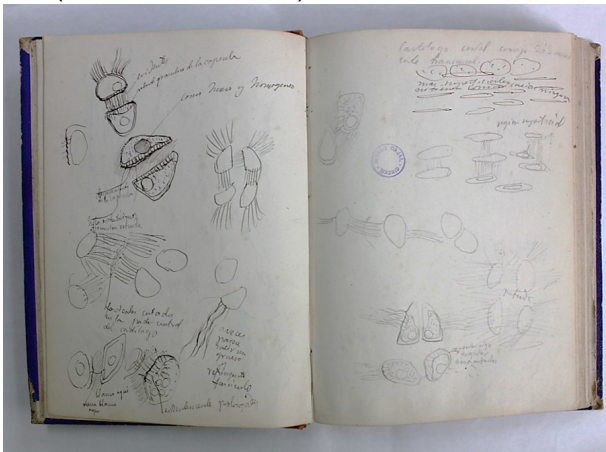


Fig 12. Diario de Observaciones de S.R.C. (Madrid, Legado Cajal, legajo 1.511). The objects represented suggest these pages were written in succession. On the left side there are ink drawings of cartilage cells. Some parts are shaded with diagonal lines to emphasise tonalities. The names Cajal included make reference to formal characteristics e.g. “como moco y homogéneo (as mucus and homogeneous)”, colours e.g. “marrón aquí, menos blanco aquí (brown here, less white here)”, and specifications e.g. “fascículos cortados en la parte central del cartilago (fascicles cut in the central part of the cartilage)”. On the right side there are some drawings in pencil and one in ink; the pencil ones are less legible. The subject description at the top reads “cartilago cortical conejo 2 o 3 veces corte transversal (rabbit cortical cartilage 2 or 3 transversal cut)”. There are parts shaded diagonally in pencil following the same method as used with ink.

pathological histology was a major concern for histologists (Valverde, 2009), Cajal took advantage of the speed of lithography compared to

other printing methods in order to publish a – limited – number of copies of his work and distribute them quickly (López Piñero, 1985: 77).

Any decision regarding printing technique produced particularities that participated in shaping the research object. Every detail added, deleted, dismissed or emphasised in the material to be engraved or incised played a part in manufacturing the image. Once printed, the image contained an accumulation of specific knowledge that was fully dependent on decisions made by the histologist or anatomist in both the staining and printing. Such techniques display the knowledge embodied in what was observed through their microscopes. From the original drawing to the printed picture, processes of discrimination took place; through the

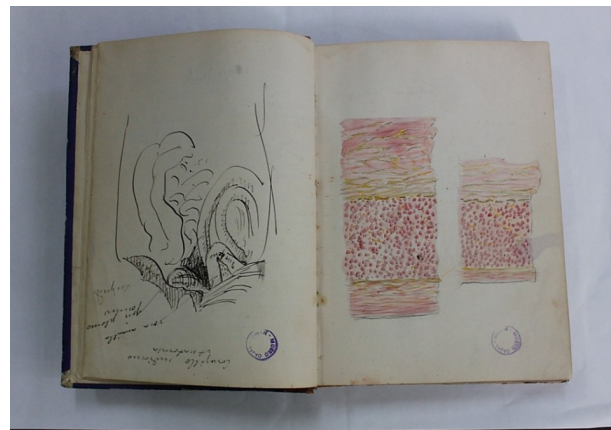


Fig 13. Diario de Observaciones de S.R.C. (Madrid, Legado Cajal, legajo 1.511). The notes on the left relate to both the black and white drawing and the colour images on the right, suggesting that one was drawn after opening the notebook upside down. On the left is an ink drawing of guinea pig anatomy with some parts labeled, including the stomach and liver. Other notes relate to colours. On the right is a watercolour drawing suggesting Cajal filled in a pencil sketch with colour. All the pages have a printed hallmark on at least one side pertaining to an inventory made in 1975 under the direction of Alfredo Carrato Ibáñez (Freire, 2002).

discarding of one technique and selection of another, methods achieved agency. In order to analyse this process of manufacturing a printed image, I will now examine the original drawings included in one of Cajal’s personal notebooks.

DIARIO DE OBSERVACIONES: CAJAL’S EARLY NOTEBOOK

“I still have a notebook, dating from 1877, where I have registered and drawn in a variety of colours [cell images] taken from neurologic texts of the time (Ramón y Cajal, 1917b: 126-127).

The Diario de Observaciones is an unpaginated

⁵With ultramarine blue cardboard covers and 320 pages, the spine has the title and author’s initials, S. R. C., raised and coloured gold. The notebook has obviously been opened and closed many times and has the general condition of a much used item. It has been preserved at the Instituto Cajal, a research centre of the CSIC (Spanish Research Council) in Madrid, opened in 1989, and at its previous location in the building of the Centro de Investigaciones Biológicas, also in Madrid. The archive of Santiago Ramón y Cajal, known as Legado Cajal, is preserved in an air-conditioned room without windows to guarantee conservation of the materials, which include original drawings, photographs and correspondence. For more information about the history of CSIC and Legado Cajal see Santesmases, 2001: 39-60; Freire, 2002; Anaya, 2002.

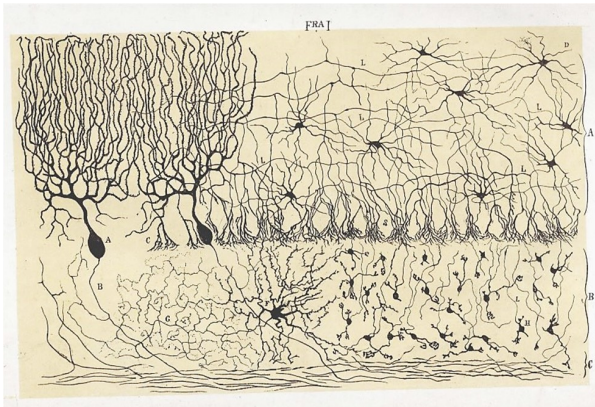


Fig 14. Ramón y Cajal, Santiago (1888). Estructura de los centros nerviosos de las aves. *Revista Trimestral de Histología Normal y Patológica*. Lithograph in black with yellowish background.

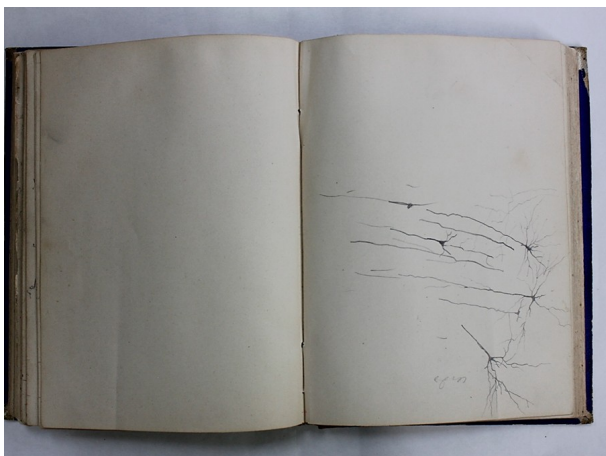


Fig 15. *Diario de Observaciones de S.R.C.* (Madrid, Legado Cajal, legajo 1.511). On the right side is one of the only representations of neurons within Cajal's notebook. The drawing was made in pencil without any textual description. There are variations in the thickness of lines.

notebook containing a set of Cajal's early sketches of cells that he observed through the microscope, including a number of neurons⁵. The pasted-down end sheet of the front cover is stamped with a letterhead conveying the name and address of where Cajal purchased the book, a bookshop in Zaragoza: "Librería de la V^a de Heredia. Plaza de la Seg. N^o2." Cajal bought the notebook in 1877 (Ramón y Cajal, 1917b: 126-127) when he was a postgraduate student (López Piñero, 1985). Both sides of the sheets are used – at times as if opened upside down – and there is rarely a continuation on consecutive pages of what could be perceived as related issues. The majority of drawings are undated, but on some pages there are handwritten notes.

For the sketches and text Cajal has used ink or pencil, or a combination of both. Not surprisingly, some of the pencil drawings are less legible than those in ink. Many are annotated with the colours

Cajal observed through the microscope, including the drawings of inflamed cartilage cells shown in Fig. 12, which are annotated with colours, object forms, dates, and the stage of inflammation or other pathological changes. The notebook includes very similar drawings to those that Cajal later published: this one can be compared with the image from his 1880 publication shown in Fig. 10. All the factors noted by Cajal are brought together in a lithograph to make the drawing reproducible. Throughout the manufacturing of the printed version, knowledge and information were transferred from the sketched drawing to the stone surface.

As well as sketches, the notebook contains pencil-coloured drawings and watercolours (see Fig. 13, right side). This suggests that drawing for Cajal meant drawing in colour. Even when not adding colour at the sketching stage, he included information about colours by the figure's side, as if he were drawing in a hurry, rapidly sketching something complex that he observed through the microscope (see Fig. 13, left side).

BLACK AS AN IDENTIFIED COLOUR

The final date recorded in the notebook is May 1888, hand-written on the pasted down end-sheet of the back cover⁶. This was the exact date when Cajal published the first issue of his self-funded journal, *Revista trimestral de histología normal y*



Fig 16. Neuroglia de la capa de las pirámides y estrato radiado del asta de Ammon. (Madrid, Legado Cajal, legajo 2690-001). Those elements closer to the viewer are thickened with ink, while more distant elements are almost indiscernible. This drawing strategy differentiates between focal planes, providing depth.

⁶El cuaderno de las terminaciones nerviosas. Desde el remate del tejido muscular a los centros inclusive 1^o de mayo de 1888" (The notebook of nerve endings. From the end of the muscular tissue to the centres).

patológica (Quarterly journal of normal and pathological histology). In the first issue, Cajal included his studies of the nerve centres of birds, for which he used a modified version of Camilo Golgi's well-known staining technique. This enabled Cajal to defend his thesis that the neuron was an individual element of the brain's nervous system (see the contributions included in this issue). The printed lithograph that he used will be discussed in the final part of this paper, together with a drawing of neurons included in the notebook, which suggests that it was used in the early stages of his research on tissues and neurons.

Having illustrated the individuality of the neuron in 1888, Cajal would publish the majority of his subsequent images in black. His modification of Golgi's staining method, which Cajal termed the *proceder de doble impregnación* (procedure of double impregnation), produced brain cells stained in black over a yellowish background, as depicted in the 1888 lithograph (Fig. 14) and the original neuron drawings in his *Diario de observaciones*, which appear in black pencil over yellowish paper without any textual description (Fig. 15). The colours reveal and reflect the staining method that he used. His skill at staining neural tissues black has been attributed to his previously acquired abilities in making and revealing photographs through the use of silver halides. Not only does Cajal refer to the process as 'toning', a photographic term (Márquez, 2004; Ramón y Cajal and López Ocón, 2016); he stained neurons with the same chemicals used to reveal photographic images.

This demonstrates, I argue, that Cajal considered black as a colour in its own right, and staining and drawing the phenomena he observed was for him the creation of a colour portrait. In Cajal's own words his drawings were "the product of the mixture of all colours, naturally including black and white" (Ramón y Cajal, 1917a). The fact that he was skilled in lithography – a technique that had already enabled him to produce colour prints – demonstrates that his use of black was not due to any limitation, but a conscious representation of the particular colours of the stained neurons that he observed. Although since 1888 the distinctive colour of his drawings and prints was black, when the tone of paper was insufficiently yellow, Cajal used ochre to comprehensively fill in the background, suggesting this was the particular colour that he observed through the microscope (Fig. 14).

A number of authors have indicated that Cajal first sketched in pencil and then used ink to highlight specific lines (Freire et al., 2003). Even the pencil lines that he sketched and did not erase are meaningful: they represent "different phases of observation" (Fiorentini, 2013). Skilled in free-hand drawing as he was, Cajal combined ink and pencil to distinguish between different focal planes (see Fig. 16) with depth created by the pencil lines conveying three dimensions (Fiorentini, 2013). As

Anne Secord (2013) has stated about the pioneering British photographer, Henry F. Talbot, an expert gaze and a professional use of artistic techniques were combined in his images of neuronal phenomena.

CONCLUSION

Taking into consideration Ramón y Cajal's expertise in producing images, both drawings and prints, provides us with a greater understanding of his scientific knowledge production. I have presented different strategies used by Cajal by focusing on his early representations of cartilage cells (Ramón y Cajal, 1880) and neurons (Ramón y Cajal, 1888), which were initially sketched and then printed as lithographs. To make the images printable, he included some elements from his drawings and omitted others.

Producing histological images required specific skills to make the technical transit from original drawings to mass-produced prints. The artistic skills and experience in drawing, photography and printing gained in his youth, led Cajal to present innovative results in his early published images and, later, in his images of neurons within the structure of the brain's nervous system. Cajal's system of producing images participated in the visual epistemology of histology, enabling his visual knowledge to circulate.

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The role played by Santiago Ramón y Cajal in the development of other disciplines: Biology, Psychology, Anthropology and Archaeology

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SUMMARY

Santiago Ramón y Cajal is well-known for his work on histology and pathological anatomy, but his scientific restlessness led him to become involved in many other fields, on which his influence also left its mark. His reputation as a histologist has concealed the other disciplines in which he took an active part, particularly after he received the Nobel Prize for Medicine that he shared with Golgi in 1906. Ramón y Cajal was a true humanist who excelled in many fields, today considered as very different disciplines. In some cases, the role he played in the development of these other disciplines has not been studied in all its depth, although his foray into the field of photography has indeed been analysed, for example. More recently, his work as a psychologist has also been published, since Ramón y Cajal came to refute the psychoanalytic theory that Freud was spreading at that time.

Less attention has been paid to his involvement in the development of other disciplines that at that time were also included in the field of Natural Sciences, such as Paleontology, Prehistory and Anthropology, and especially as a result of his position as director of the different institutions that he came to preside, especially after receiving the Nobel Prize in Medicine. This, then, is the objective of our contribution.

Although he was most notable for his management as president of the Junta para la Ampliación

de Estudios (Committee for Extension of Studies and Scientific Research- JAE), we should not forget that he was also president of the Spanish Society of Natural History, director of the Laboratory for Biological Research, and honorary president of the Spanish Society of Anthropology, Ethnography and Prehistory. In all these institutions he played an outstanding role.

Key words: Ramón y Cajal – Prehistory – Anthropology – Committee for Palaeontological and Prehistoric Research – Spanish Society of Anthropology – Ethnography and Prehistory

INTRODUCTION

Santiago Ramón y Cajal (b. Petilla de Aragón, 1-5-1852, d. Madrid, 17-10-1934) is well known for his work on histology and pathological anatomy, but his scientific restlessness led him to become involved in many other fields, on which his influence has also left its mark. His role as a histologist has occluded the other disciplines in which he took an active part, particularly after he received the Nobel Prize for Medicine, shared with Golgi in 1906. Ramón y Cajal was a true humanist who excelled in many fields, today considered as very different disciplines. In some cases, the role he played in the development of these other disciplines has not been studied in all its depth, although his foray into the field of photography, for example, has indeed been studied (Duce Gracia, 2002; Márquez, 2004; Sánchez Vigil, 2008). More recently, his work in the field of psychology has also been published (Rallo et al., 2014), showing how Ramón y Cajal came to refute the psychoanalytic theory that Freud was spreading at that time,

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proposing an alternative theory. To round off this image of Cajal, suffice it to say that this scientist should be seen not only as a scientific renovator, but also as a social reformist (González de Pablo, 1998) within the scientific regenerationism with which he is associated (Ayala, 1998).

However, less attention has been paid to his involvement in the development of other disciplines that at that time were also included in the field of Natural Sciences, such as Paleontology, Prehistory and Anthropology. Indeed, even before receiving the Nobel Prize, Ramón y Cajal had been the president of the Spanish Society of Natural History (SEHN) in 1897. We need not be surprised at his leadership of this society, despite being a physician, if we remember that the SEHN was created in 1871 with a majority of physicians among its founders, and that its first headquarters was actually in the Royal Academy of Medicine. Apart from the well-known role played by the SEHN in the consolidation and circulation of the scientific work carried out by Ramón y Cajal and other members of the Spanish School of Neuro-Histology (Baratas, 1998), we should bear in mind that in this society Ramón y Cajal mixed with the most important biologists, geologists, paleontologists and prehistorians of the time.

The objective of this paper is to analyse the role played by Santiago Ramón y Cajal in the development of these other disciplines, other than Pathology and Histology, especially in view of his direction of the different scientific organizations and societies that he presided over after winning the Nobel Prize for Medicine.

SANTIAGO RAMÓN Y CAJAL AND THE JUNTA PARA LA AMPLIACIÓN DE ESTUDIOS

The Royal Decree of 11 January 1907 set up the Junta para la Ampliación de Estudios e Investigaciones Científicas (JAE), the Committee for Extension of Studies and Scientific Research, under the intellectual and ideological control of members of the Institución Libre de Enseñanza (Free Education Institute), in which an important role was played by Eduardo Hernández-Pacheco. The JAE helped to set up a programme for the reconstitution and Europeanisation of Spain through a policy of overseas scholarships and the creation of the scientific and educational resources necessary for the knowledge acquired abroad to be made available to Spanish society (López-Ocón, 2010, 164): Santiago Ramón y Cajal was its president from the moment of its foundation until his death in 1934. Ramón y Cajal was without any doubt at that time the most prestigious Spanish scientist, as he had shortly before received the Nobel Prize for Medicine.

The Royal Decree included the appointment of Ramón y Cajal as a director, together with other of the most prestigious Spanish scientists of the first

third of the twentieth century. The greatest burden of the JAE fell on Santiago Ramón y Cajal himself, Castillejo (his right-hand man at the JAE), Cabrera, Simarro, and Bolívar, who was its second and last president. The JAE was then dissolved after the Civil War, and all the existing scientific institutions at the time were incorporated into the recently created Consejo Superior de Investigaciones Científicas (CSIC) (Puig-Samper, 2007).

Since its foundation by a Royal Decree, the JAE resumed the tradition of overseas training, following the precedent in previous centuries of some of the greatest reformers and promoters of science in Spain, such as Antonio Gimbernat (1734-1816) in the eighteenth century and Juan Vilanova in the nineteenth. This was another example of how profoundly the JAE was impregnated with the predominant Regenerationism of that time.

Different institutes and laboratories became part of the JAE, forming an impressive scientific structure that became a hotbed for scientists who took Spanish science to the highest levels in the first third of the twentieth century. To give some idea of the JAE under Ramón y Cajal's direction, we shall briefly mention some of the centres that it included. Pride of place must go to the Instituto Nacional de Ciencias Físico-Naturales (INCFN), the National Institute of Physical and Natural Sciences, created by the Royal Decree of 27 May 1910, with Ramón y Cajal as president and Blas Cabrera as secretary. The INCFN would incorporate, among others:

The Biological Research Laboratory, which had been set up in 1900 had been under the direction of Ramón y Cajal since its inception (González de Pablo, 1998).

The National Museum of Natural History, chaired by Ignacio Bolívar.

The Museum of Anthropology, chaired by Manuel Antón, of which more later, since it was there that was founded the Spanish Society for Anthropology, Ethnology and Prehistory, of which Santiago Ramón y Cajal was Honorary President.

The Botanical Garden, under Antonio Gredilla.

The Marine Station of Santander, founded by Augusto González Linares.

The Marine Station of the Balearics, founded by Odón de Buen.

The Automation Laboratory, directed by Leonardo Torres Quevedo.

The Committee for Palaeontological and Prehistoric Research, which I shall also deal with later, and which was directed by Eduardo Hernández Pacheco.

Together with the INCFN, the other major centre set up within the JAE was the Centro de Estudios Históricos (CEH), Centre for Historical Studies. Introduced by the Royal decree of 18 March 1910, it was headed by Ramón Menéndez Pidal (1869-1968), and other members were Eduardo Hinojosa (1852-1919), Rafael Altamira (1866-1951), Américo Castro (1885-1972) and Pedro Bosch Gimpera

(1891-1974), as the most distinguished members. The object of study of this centre was anything that could contribute historical knowledge and, most particularly, that relating to Archaeology. To this end an Archaeology section was set up within the CEH, and started work in 1914. This was coordinated by Manuel Gómez Moreno (1870-1970), and members also included Juan Cabré (1882-1947), Cayetano de Mergelina (1890-1962) and Diego Angulo (1901-1986) (Ayarzagüena, 2018).

SANTIAGO RAMÓN Y CAJAL AND THE COMMITTEE FOR PALEONTOLOGICAL AND PRE-HISTORIC RESEARCH

The Committee for Paleontological and Prehistoric Research (CIPP) was created in 1912, also within the JAE, and was the first public body in Spain dedicated to this field (Moure, 1996)¹.

Although the proposal to create the CIPP came from Eduardo Hernández-Pacheco and the Marquis of Cerralbo, Santiago Ramón y Cajal and Ignacio Bolívar should be highlighted as key figures for its formal creation (Sánchez Chillón, 2013). From a regenerationist point of view, it is worth pointing out that this body served in Spain as a counterweight to the work being carried out in our country by the Institut de Paleontologie Humaine (IPH) at the time and until the First World War. The IPH, as we shall see later, had been created in Paris a few years before the CIPP, and was carrying out in Spain what has come to be known as "imperialist archaeology" (Díaz-Andreu, 2002: 103-117).

The initiative for the creation of the CIPP came when Eduardo Hernández Pacheco, who maintained good relations with Santiago Ramón y Cajal, while staying in Paris, met Enrique de Aguilera y Gamboa, Marquis of Cerralbo. Between them they agreed to create a Spanish institution to control prehistoric investigations done in this country². Cerralbo would become the first director of the institution and Hernández-Pacheco would be the Chief of Works and Director of Publications (Rasilla, 1997). The latter would likewise become the director after 1922, after the death of the Marquis of Cerralbo. Other notable members of the committee were the most important Spanish prehistorians of the first third of the twentieth century, such as Juan Cabré, the commissioner of explorations, and collaborators of the Count of la Vega del Sella (1870-1941), Hugo Obermaier (1877-1946), Paul Wernert (1889-1972), Pedro Bosch Gimpera (1891-1974), Orestes Cendrero (1887-1946), Ismael del Pan (1889-1968) and Francisco Benítez Mellado (1883-1962). The headquarters of

the Committee was established in the Natural History Museum (which, as has been said, formed part of the JAE), and although its territorial extent covered the Iberian Peninsula, the Palaeolithic sites of Asturias took precedence. If we look at it, this implied that in prehistoric studies the Natural History Museum took precedence over the National Archaeological Museum, and over and above personal factors (the conflict over the personal interests of those supporting each of the proposals) there was a technical confrontation between those who argued that Prehistory was a natural science and that, methodologically, it actually functioned as a natural science, and those who maintained that it was a social science. Combined with this was an external factor: the creation in Paris in 1910 of the Institut de Paleontologie Humaine mentioned above, by Prince Albert I of Monaco, under the direction of Marcelin Boule, and the barely-concealed conflict between members of the IPH and the Spanish prehistorians.

To place in context how this confluence came about between the IPH and members of the JE, we should bear in mind that in 1906 the Frenchman Henri Breuil and the German Hugo Obermaier (1877-1946) (a disciple of Breuil and an adherent of the diffusionist line of the historical-cultural School of Vienna) contacted Prince Albert I of Monaco during the XIII International Congress of Anthropology and Prehistoric Archaeology held in Monaco. The fame of Altamira had spread across frontiers, and Albert I asked Breuil and Obermaier to show him various Cantabrian caves with prehistoric remains. That led to a sponsorship of Breuil's research in Spain, with the publication of the monograph on Altamira (Cartailhac and Breuil, 1906). He would likewise sign two contracts with Alcalde del Río, with which he financed the excavations by Alcalde del Río and Lorenzo Sierra (1872-1947) of El Castillo and other caves in Cantabria in 1906 and 1909, but promising that the material found would remain in Santander. And in 1911 the work *Les Cavernes de la Région Cantabrique* was published.

Young Henri Breuil and Hugo Obermaier, Professors of the IPH, the former of Prehistoric Ethnography and the latter of Quaternary Geology, would play a very important role in the development of Spanish Prehistory. This would be between 1910 and 1914, when the IPH centred its research on the excavations of the cave of El Castillo, and it was visited by researchers of international standing, such as Teilhard de Chardin (1881-1955), Paul Wernert (1889-1972) and Ferdinand Birkner (1868-1944). Encouragement was given to the training of local archaeologists of the stature of the

¹Although the Spanish Prehistoric Society had already been created in 1868, consisting of Juan Vilanova y Piera, Francisco María Tubino y Oliva, and José Amador de los Ríos y Serrano, when the latter was appointed as director of the National Archaeological Museum; but since in the same year the Septembrina, or Revolution of 68, took place and Amador de los Ríos had to leave the direction of the Museum, the Spanish Prehistoric Society never really came into being. Consequently, the CIPP was in reality the first Spanish public body that was dedicated in depth to prehistoric studies.

²Prehistory was understood as the archaeology of the Pleistocene, since they rarely dealt with the Neolithic or Metallic Ages.

Count of la Vega del Sella (1870-1941), and they would play an important role.

Cajal's involvement, both professional and personal, in prehistoric studies was clear, not only from the boost given by the creation of the CIPP, but also from his later support for and direct participation in the activities of the CIPP. Thus, at the end of July 1914, he visited the excavations of the cave of La Paloma that Eduardo Hernández-Pacheco was directing at that moment, and even took part in the excavation work (Fernández-Tresguerres, 1980). Another cave that we know he visited, and more than once, was that of El Castillo: on one of his visits he was shown around by Father Jesús Carballo, a great Cantabrian prehistorian of the time.

SANTIAGO RAMÓN Y CAJAL AND THE SPANISH SOCIETY OF ANTHROPOLOGY, ETHNOLOGY AND PREHISTORY

As we shall see, Santiago Ramón y Cajal played a leading role in the Spanish Society of Anthropology, Ethnology and Prehistory (SEAEP), created in 1921 on the initiative of Manuel Antón y Ferrándiz, the first professor of Anthropology of the Central University. While Ramón y Cajal's involvement in the Society has passed practically unnoticed in the bibliography that I have consulted, his influence was very considerable, not only because he was a founding member³ and Honorary President of the society⁴, but because it is clearly shown in many other aspects. Santiago Ramón y Cajal had a house built next to the Velasco Museum, the place that would be the headquarters of the SEAEP, and where he would have his office.

From the beginning the society was very active, as reflected in its minutes, the *Actas y Memorias de la Sociedad Española de Antropología, Etnografía y Prehistoria*. But shortly before Cajal's death, the SEAEP suffered a serious crisis, both of a scientific nature and of internal struggle: the first sign was the request for Santiago Ramón y Cajal to quit the office that he had in González de Velasco's anthropological museum⁵. No clear reasons have been found yet to explain this crisis, which would continue until the Civil War. The scientific decline is very closely related to Ramón y Cajal's loss of influence in the society and subsequent death. It seems shocking that practically

none of the studies of Cajal mention his position as Honorary President of the SEAEP. So, for example, in the interesting study that Luis Ángel Sánchez Gómez has made of the SEAEP he makes absolutely no mention of the role that Ramón y Cajal played as Honorary President. However, his death coincides with a marked decline in the society, as shown by Sánchez Gómez (1990):

"(...) in this first stage of the Society (until the Civil War), the years 1934 and 1935 show a certain decline in its activity. Apart from the fact that the journal printed no articles on an ethnographic subject during those two years, it is the actual minutes of the sessions that reveal the situation. The meetings are limited in practice to the reading of speeches. Debates, discussions and information on the activities are reduced to a minimum".

And what could be the reason for this "neglect" of Ramón y Cajal in the historiography? The origin, as we shall see, lies no doubt in the bad relationship that Ramón y Cajal had with the new generation of prehistorians and anthropologists, which caused the neglect to become obvious. This is helped by the fact that the archives of the SEAEP have disappeared⁶. What happened to them? It is not clear, but I understand that it was either people close to Ramón y Cajal who took them after the "crisis of 1933" in the Society, or else his successors who made the documents disappear in order to delete any trace of its founders; what is certain is that today this documentation has disappeared.

The clearest evidence of Santiago Ramón y Cajal's fall from grace in the SEAEP, as well as of the internal squabbles in the Society, was the event that, after Cajal's death, the Society held in his memory on 14 May 1935⁷. In this necrological session what was clear was the hostility that Ramón y Cajal aroused among the new board of directors of the SEAEP. The speech was prepared by Domingo Sánchez, a faithful disciple of Ramón y Cajal, who had been the secretary of the SEAEP while Cajal was the honorary president of the Society, and the text was very much a hagiography of the deceased. However, in the SEAEP nothing was said about his participation in the Society; there was not even a comment about how and when he was appointed as its honorary president, except to mention that he had held the post and had been a founding member.

³He appears as such in the list of members published in the first years of the society's minutes, *Actas y Memorias de la Sociedad Española de Antropología, Etnografía y Prehistoria*.

⁴This is reflected in the *Actas y Memorias de la Sociedad Española de Antropología, Etnografía y Prehistoria* of the first years. Although the notice of his appointment no longer exists, in the archive of the Cajal Institute there is a letter, dated 3 May 1922, from Cajal himself addressed to Luis de Hoyos Sainz, in which he informs him that he has received the official notification informing him of his appointment as Honorary President of the Society. Archive Cajal-Biblioteca. Código: AR73668501.

⁵Letter from the Director of the National Museum of Anthropology, dated 13 November 1933, proposing the enlargement of the museum, for which it is required that the premises occupied by the Cajal Laboratory and the Faculty of Science be given up to the National Museum of Anthropology. Reference: ACN0438/038.

⁶There appears to be a jinx on anthropological societies in Spain. The archive of the Spanish Anthropological Society, founded in 1865, disappeared, and it has always been said that it was the wife of Pedro González de Velasco who burnt the archive. This seems unlikely, bearing in mind that Velasco counted on Pulido who helped his wife when she was widowed, and it is hard to believe she could have burnt the archive without his permission.

⁷ABC, 14 May 1935: 36.

Furthermore, the board did its level best to prevent that speech from being published. At first, in a letter dated 10 November 1935, the Vicesecretary of the Society told its author, Domingo Sánchez, that he should reduce the text to just four pages, since "it was not about a purely scientific subject"⁸.

A month later, in the session of 11 December 1935 of the SEAEP, the board refused to allow the Society to print in their publications the biography written by Domingo Sánchez, adducing that there were articles waiting to be published and that their publication could not be delayed. The truth is that, as Domingo Sánchez revealed, there was no such need. When the issue was put to the vote, the publication was opposed by members of the board, such as Barras de Aragón, Antonio García y Bellido, José Ferrandis, Hugo Obermaier, and Martínez Santa Olalla, as well as other distinguished archaeologists and anthropologists such as Pérez de Barradas y Julio Caro Baroja. On the other hand, naturalists and some prehistorians from the CIPP, like Juan Cabré and some old members of the CIPP voted in favour. In this way, publication by the SEAEP was rejected; but it was eventually published, because Domingo Sánchez and a group of Cajal's staunch supporters paid for its publication from their own pockets (Sánchez y Sánchez, 1936).

If we look at who was on either side, we can see that those in favour of Cajal were basically physicians, naturalists and prehistorians, more closely related to the natural sciences; and against were those archaeologists, prehistorians and anthropologists more in line with the social sciences. Perhaps the underlying cause of the conflict was the endowment of the Chair of the Primitive History of Man in favour of Hugo Obermaier in the Faculty of Philosophy and Letters in 1922, precisely a year after the creation of the SEAEP, despite the opposition of those who thought that the Chair should be in the Faculty of Natural Sciences, such as Hernández Pacheco and all those who had fought to stop the French IHP from colonising Spanish prehistory. Very possibly these internal conflicts also had a great deal to do with the fact, hitherto unexplained, that the XV International Congress of Anthropology and Prehistoric Archaeology, held in Lisbon in 1930, took place in our neighbouring country and not in Madrid, as expected. Given that this is a field that has yet to be explored, what is presented here is the initial result of our research that we hope will soon bear fruit.

CONCLUSIONS

Although Santiago Ramón y Cajal's major contribution was undoubtedly in Histology and Pathological Anatomy, his contribution was also made in many other disciplines, such as Biology, Psycholo-

gy, Anthropology and Prehistory. His contribution to Prehistory and Anthropology was very noteworthy, particularly from the management and methodology of his work as president of the Junta para la Ampliación de Estudios.

His participation in the CIPP is relatively well known: a subsidiary of the JAE, it was an institution which fought for the development of the prehistory of this country and against the French colonialism fostered by the IPH. But his role in the SEAEP has been practically unknown, partly due to the internal conflicts within the Society dating from shortly before Cajal's death. However, these conflicts marked a whole way of dealing methodologically with prehistoric studies in the second third of the twentieth century which, in some way, has lasted until our own day.

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⁸Archive of the Cajal Institute. Fondo documental 9896.

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Modern Spain, a myth: regeneration through reeducation in Santiago Ramón y Cajal's *Vacation Stories* (1905)

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SUMMARY

This essay explores the regenerationist thought of Santiago Ramón y Cajal in his *Vacation Stories* (1905). Two stories of the collection, "The Accursed House" and "The Natural Man and The Artificial Man", can be read as an allegory of Spain at the end of the century nineteenth. In "The Accursed House", the indiano scientist Julián tries to convince Inés to adopt the same scientific perspective of the world that he has. Similarly, he sets out to regenerate his degenerated manor, to which he has given the suggestive nickname Villa Inés. The story serves as a model for the regeneration of Inés, who represents traditional Spaniards, and Villa Inés, which represents Spain. For its part, the story of Esperaindeo Carcabuey in "The Natural Man" offers a warning, as it tells of his failed life, which he links directly with his inferior education (impregnated as this was with metaphysics). Only by adopting Jaime's progressivism can Esperaindeo change the direction of his life. In both stories, Cajal links the reeducation of the characters with his more comprehensive interest in national regeneration. In view of the allegorical impulse of these stories, *Vacation Stories* constitutes a foundational myth on which Cajal constructs his vision of a modern Spain.

Key words: Ramón y Cajal thoughts – Nineteenth

Century – Regeneration – Reeducation

Like so many of his compatriots of the fin de siglo period, Santiago Ramón y Cajal was deeply invested in the so-called problem of Spain and Spanish national regeneration¹. In contrast to politicians like Joaquín Costa, however, who pursued regeneration through political means, Cajal opted for what Laín Entralgo has referred to as a vocational approach. In speaking of the generation of men to which Cajal belonged, Laín calls them "men who, favored by the haven of peace and freedom offered by the Restoration of 1875, devoted themselves with zeal, calm and technical know-how to the effort of cultivating science seriously, and who were interrupted in their task by the disaster of 1898 (Laín Entralgo, 1978, p. 58)." Cajal preferred to make his mark on Spanish society through his own research as well as through his associations with scientific-educational institutions like the Junta para la Ampliación de Estudios (The Board for Advanced Scientific Studies and Research), over which he presided for numerous years, rather than in parliament². Although he was offered significant political posts, he always declined them (Ayala, 1998, p 37, 39 n19; Rodríguez Quiroga, 1999, p 712)³.

Cajal's approach to national regeneration also differed from that of his literary peers, the Generation of '98, who responded to the colonial disaster

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²For an overview of Cajal's relation to the JAE, see Sánchez Ron (2006, p 28-40).

³For Cajal's ideas on the relationship between science and the state, see Sánchez Ron (2006).

with “contemplative, aesthetic, and apolitical approaches” (Ayala, 1998, p 35). Although Cajal was deeply impacted by Spain's defeat in Cuba, he remained optimistic about the future of the country, which is reflected in the tone of his literature. One reason for his optimism may be that he did not view Spain as degenerate per se; rather, he felt the country's biggest problem was its education (or lack thereof): “Spain is not a degenerate nation, it is an uneducated nation” (Advice p 139, emphasis in the original). In light of this view, it is not surprising that, in his writings, Cajal advocated for educational reforms (Rodríguez Quiroga, 1999, p 706; Sosa-Velasco, 2010, p 43). Indeed, on the eve of Spain's capitulation to the United States, for instance, he penned an editorial in *El Liberal* advancing a number of concrete measures aimed at improving Spain's scientific education.

The article built on ideas Cajal had expressed a year earlier in a speech he delivered to the Royal Academy of Exact, Physical, and Natural Sciences, which was later published as *Advice for a Young Investigator*. The speech was so influential that a revised edition was distributed free of charge to “Spanish university youth” (Ayala, 1998, p 33)⁴. In the prologue to the revised edition of *Advice*, Cajal laments his own early troubles as a scientific researcher hampered by Spain's infrastructural shortcomings. In the final paragraph he makes an impassioned plea for Spain's future: “Hopefully this humble pamphlet, which is addressed to the studious among our youth, serves to strengthen interest in laboratory tasks, and to encourage the hopes of those who believe in our scientific and intellectual renaissance; hopes that are somewhat deflated in the aftermath of recent and overwhelming disasters”. (*Advice* 16, my translation)

If, in texts like *Advice*, Cajal lays out concrete ideas for national regeneration, it is in his *Vacation Stories*, a work of creative fiction, where he provides an image of what that regeneration might actually look like. In what follows, I will argue how Cajal elaborates—primarily in “The Accursed House” but also in “The Natural Man and the Artificial Man”—a literary-mythological foundation on which his vision of a modern, regenerated Spain can be constructed. “The Accursed House” begins with an anxious Inés awaiting the return from Mexico of her fiancé Julián, a medical doctor and bacteriologist. Their plans to wed are interrupted by a shipwreck en route that robs Julián of his fortune. Determined to overcome his ill fate, Julián purchases a diseased property, the eponymous “accursed house”, which he suggestively dubs *Villa Inés*, with the aim of converting it into a prosperous homestead (Cajal, “The Accursed House” 69).

Despite sundry challenges, Julián ultimately succeeds, and the couple is able to marry and live happily ever after. Various scholars—including Tzitsikas (1965, p 49), Sosa-Velasco (2010, p 29-30), and Otis (1999, p 78)—have highlighted the allegorical function of the story, recognizing in *Villa Inés* a symbol of fin de siglo Spain. Less attention, however, has been paid to the parallel process of Inés's conversion to Julián's scientific worldview and its equally allegorical significance. Although the allegory posits a modern view of Spain, it nevertheless reinforces conservative gender roles, as the text tropes woman as tradition and man as scientific progress.

The allegorical thrust of “The Accursed House” is echoed in the final story of the *Vacation Stories*, “The Natural Man and the Artificial Man”, which scholars have also read as “an allegory of Spain's fledgling modernity” (Pratt, 2001, p 100). In the story *Esperaindeo Carcabuey*, the “artificial man”, recounts his life of failure to his old *Ateneo* debating rival and “natural man”, Jaime Miralta (Cajal, “The Natural Man” 223). Now a successful engineer and factory owner in France, Jaime explains that his friend's problems stem from his inferior education, plagued as it was by metaphysics. He offers the story of his own life as a model for *Esperaindeo* to follow. His education, unlike that of his friend's, was based on direct contact with nature. As Pratt has argued, the fact that *Esperaindeo* adopts Jaime's worldview, as Inés does Julián's, reverberates beyond the boundaries of the story, “forshadow[ing] changes in [Spanish] society” (88). In both “The Accursed House” and “The Natural Man and the Artificial Man”, then, Cajal advocates for national regeneration by linking it with a scientific oriented reeducation. To appreciate how this process plays out, I turn first to “The Accursed House”.

Julián's regenerationist project comprises two related efforts: reviving his rundown homestead and converting Inés to his scientific worldview. *Villa Inés* is located roughly equidistant between the towns of *Villaencumbrada* and *Rivalta*. *Villaencumbrada*, the capital of the region, with its root-word *encumbrar*, meaning to exalt or elevate, stands for a modern, idealized Spain, while *Rivalta*, the rival of *Villaencumbrada*, symbolizes a traditional Spain resistant to change and unfamiliar with modern scientific advancements. As it turns out, *Rivalta* also happens to be the hometown of Inés. The geographic location of *Villa Inés* highlights Julián's role as mediator⁵. His constant movement back and forth between the two towns serves his ultimate purpose of refashioning *Rivalta* after the image of *Villaencumbrada* by applying the same (scientific) principles there as he does at *Villa Inés*.

⁴Ayala offers a concise overview of the evolution of Cajal's speech. The text based on the talk would ultimately go through sixteen editions (including the original speech) between 1897 and 1971. Its current title, *Los tónicos de la voluntad (Reglas y consejos sobre investigación biológica)*, dates from 1941.

⁵Otis and Sosa-Velasco both locate the homestead in *Villaencumbrada*. My stance is that Cajal highlights the in-between position of the estate in order to preserve Julián's mediating function: it lays “within sight of *Villaencumbrada*” (p 110, my emphasis).

Julián's success with Villa Inés is largely dependent on the scientific experience he gains in the New World, which draws attention to the fact that he is an indiano. However, although Cajal's representation of Julián reflects "the two visions of the indiano that circulate in the cultural imaginary of the time", namely his "otherness" and upward social mobility (Sosa-Velasco, 2010, p 30), the text actually deemphasizes his indianismo⁶. A comparison with Agustín Caballero, from Galdós's *Torment*, which was published only a year earlier than Cajal's text, will make this point clear. Unlike Agustín, Julián returns relatively unscathed from his American experience. In describing Agustín's "physical decay" (41), the narrator of Galdós's novel (1996) remarks: "His complexion was very bad: the colour of America, the hue of fever and exhaustion in the intense damp heat of the Gulf of Mexico, the badge or mark of the colonizing mission which is building the mighty civilizations of the Spanish American world with the blood and health of so many noble workers" (p 42). Agustín's tan serves as a permanent mark of his indianismo, which the narrator associates with illness ("hue of fever")⁷.

Julián, too, returns from the New World with darker skin, but his tan does not register decadence the way Agustín's does. When Julián finally returns to Spain, the narrator describes his reunion with Inés: "It is impossible to describe the effusion of joy Inés experienced some days later when she saw Julián arrive safe and sound, a handsome young man tanned by the sea air and more in love and devoted than ever!" (Cajal, "The Accursed House" p 74). In stark contrast to Agustín's physical decadence, Julián's tan seems like the outcome of an extended summer vacation, a sign of his good looks ("a handsome young man") more than of the trials and travails the indianos faced in the New World. It is important in this respect to recognize that the passage is focalized through Inés, whose knowledge of the Americas, as a young nineteenth-century Spanish woman, would have been second-hand at best, mediated through Julián, who likely would not have emphasized his pain and suffering in his letters.

The text's elision of the New World experience is not limited to the perspective of an ingenuous Inés, however. The following passage represents part of the narrator's most detailed description of Julián's time in Mexico:

our doctor set up a magnificent laboratory in his

house for bacteriological, histological, and chemical analysis. In his library, he collected the world's most important scientific journals, and he devoted himself fervently to profound, luminous studies of the etiology of infectious diseases in tropical climates. The savory fruits of this intense labor were solid medical knowledge and scientific prestige so high and undisputed that in Mexico, our doctor passed as a supreme authority on hygiene and pathological matters. (p 82).

The passage is notable as much for what it says as for what it omits. In contrast to the vivid details Agustín Caballero gives of the Mexican-American border-towns where he worked and lived, the narrator of "The Accursed House" offers virtually no details about the Mexico Julián inhabited, except to point out that it is the place where he developed his scientific prowess. Rhetorically, the text reduces Mexico to little more than a placeholder; Julián could just as easily have studied tropical diseases in, say, Cuba, where Cajal himself spent time as a military physician⁸. Furthermore, the effusive and celebratory tone of the passage obscures any sense of the hardships he likely would have faced, and which others certainly did face, as an indiano⁹.

Although an indiano by definition, Julián has more in common with late nineteenth-century microbe hunters, a term Paul de Kruif uses to describe, inter alia, famous bacteriologists like Robert Koch and Louis Pasteur. The laboratory Julián sets up in his home in Mexico, the fact that he keeps up on the latest scientific research, and the success he has investigating tropical diseases all align him with this type of scientist. Indeed, like Koch, whose groundbreaking discoveries in the field of bacteriology were partly the product of his time in colonial Africa, Julián gains notoriety by identifying and eradicating the bacterial infestations of Villa Inés, which has led Laura Otis to refer to him as "[a]n inverse colonial . . . [who] comes from a colony to reconquer the mother country" (p 79). The significance of Otis's inclusion of "inverse" in her characterization of Julián should not be understated, for it highlights how the colonialist logic of the text is oriented inward toward the decadent nation, not outwards towards its colonies. Cajal patterns Julián after the microbe hunters, who are foreign scientists, rather than the indiano of Spanish literary history, because he believed Spanish national regeneration depended on mimicking a (northern) European mode of modernization. In this he resembles other liberal analysts

⁶Mary Coffey (2010) has identified a similar narrative impulse to separate Spain's peninsular culture from its colonial experience in nineteenth-century costumbrista literature, as well as the obverse impulse to join the two (n.p.). On the figure of the indiano in the Spanish context, see Coffey (n.p.), Fernández Cifuentes (2007, p 34-41), Surwillo (2010, p 54-65), and Gómez-Ferrer Morant (1989, p 25-49).

⁷On the association between skin color and cultural otherness in the context of indianismo, see Coffey (n.p.) and Surwillo (2010, p 56-61).

⁸Sosa-Velasco argues Julián's stint in Mexico plays a more significant role in the text (p 31). In the closing scene of "The Natural Man and the Artificial Man", which also constitutes the concluding pages of *Vacation Stories*, Jaime Miralta signals a shift in focus away from the physical geography implied by colonialism and towards the moral geography of national regeneration when he tells Esperaindeo Carcabuey: "Ah, how little the unfortunate nations would regret the loss of their colonies if their sons, burning with holy patriotism, would try to broaden the moral horizons of their peoples. If only they could develop the radiant islands of their intelligence, sanctified by peace and hard work and inaccessible to conquerors or deserters!" (p 306).

⁹Julián's lack of figurative New World baggage distinguishes him from Pepe Francisca of Clarín's "Boroña", who longs to recuperate his authentic pre-American identity and experiences (Fernández, 1996, pp 36-41). Unlike Pepe, Julián has no difficulty moving on with his life after returning from Mexico.

of Spanish "belatedness" who have pressed for a "fast-track modernization that sees the Spanish past as something to be relegated to oblivion as fast as possible" (Labanyi, 2000, p 90).

Cajal's efforts rhetorically to elide Spain's colonial past and focus on the national problems of the present are further reflected in a narrative shift in relation to Julián's homestead. Initially Julián sees in Villa Inés the potential for "the way to reclaiming wealth and happiness" (115). The Spanish term Reconquista, translated in the passage as "reclaiming", evokes the 800-year struggle between Christians and Muslims, as Otis (1999, p 78-79) has remarked. However, once he successfully reconquers Villa Inés from its occupiers (noxious microbes), he engages in a series of "regenerative campaigns", making available the "lifesaving sera and vaccines produced at Villa Inés" throughout the region and country (p 118). It is worth noting that such campaigns formed part of the cultural landscape of fin de siglo Spain (Medina Doménech and Rodríguez Ocaña, 1994, pp 79-94). The narrative shift from Reconquista to "regenerative campaigns" thus signals Cajal's preference for a regenerationist paradigm over a colonial-imperial paradigm. At the same time, it should be pointed out that Cajal's regenerationism never fully abandons a colonialist logic. Although Julián effectively eliminates the colony of noxious bacteria infesting Villa Inés, he merely replaces it with another type of colony: "The fields, once so lonely and poisoned by the effluvia of death, were quickly covered with a noisy, active colony of engineers, foremen, and workers. . ." (p 119, my emphasis). Within this colony of workers, there remains a strict sense of hierarchy. The various workers view Julián as a "second God", and the narrator describes him as "the indisputable lord of the land: the compassionate, paternal enlightened despot; the scientific, patriotic boss" (p 119).

The privileged position Julián occupies vis-à-vis the townsfolk in the narrator's estimation (he calls him "our hero" [p 119]) is consonant with Cajal's own views about social stratification¹⁰. Although Cajal recognized the power of an individual to improve his circumstances, he believed in the practical need to subordinate the masses to governing elites. And while the specter of Spanish colonialism haunts the text, it seems clear enough that Cajal's primary concern in "The Accursed House" is regenerating a degenerate nation by adopting scientific principles, not by recuperating lost imperial colonies.

The narrator's praise for Julián, when considered alongside his concomitant critique of the townsfolk, points to an inherent social hierarchy that under-

girds Julián's vision of a modern Villa Inés, and by extension Cajal's vision of modern Spain. In this hierarchy, Julián occupies a position of superiority vis-à-vis his neighbors because of his scientific outlook on life, but also because he actively applies his knowledge to the regeneration of his homestead. By contrast, the narrator criticizes the townsfolk because they espouse superstitious beliefs, and even in the case of citizens who share Julián's scientific perspective, the narrator criticizes them because they do not apply scientific knowledge like Julián does¹¹. As each of the three previous owners of Villa Inés abandon the estate after being adversely affected by its bacterial infestation, the townsfolk ascribe their misfortune to a combination of divine intervention and superstitious causes: "popular superstition had embroidered dark, ominous legends on that background of tragic realities. In the eyes of the ignorant, fanatical villagers, that estate . . . was accursed by God . . . [and] served as a dwelling place for witches and demons" (80). Cajal's use of the verb 'to embroider' suggests the "dark, ominous legends" are mere decoration. As non-essential trivia, they do not communicate important information. In this way, he rhetorically dismisses the townsfolk's perspective as specious and inane: the Rivalta residents are ignorant fanatics given to superstitious explanations.

Conversely, Julián possesses scientific knowledge, which allows him to see the diseased condition of the estate for the natural phenomenon that it is: "Julián saw from the first what was wrong with the Accursed House. The misfortunes to which the abandoned estate owed its dark reputation were a simple consequence of the natural conditions of the terrain and environment..." (p 83). The immediacy with which Julián recognizes the problem reinforces his image as a knowledgeable, self-assured scientist. The fact that he dismisses the townsfolk's explanations as unworthy of "serious thought" lends his views an air of importance and weightiness while it lends those of the townsfolk an air of triviality (p 83).

On the sliding scale of social hierarchy in Rivalta, women at times fare worse than men, even when they engage in similar activities. In this way, the text reflects a subtle gender bias by insinuating that women are by nature inferior to men. While Julián is laid up at home after a riding accident, Inés decides to sneak out one night to visit him. He surprises her by snapping a photograph of them kissing¹². Coincidentally, a group of fisherwomen passing by sees the outline of Julian and Inés's figures against the red light of the magnesium flash. The narrator notes how the women's terror—

¹⁰See Carlos Forcadell Alvarez (2006) for Cajal's response to Costa's survey on "Oligarquía y caciquismo" (p 49).

¹¹The criticism of religion figures prominently in "The Natural Man and the Artificial Man". According to O'Connor, it was in part Cajal's treatment of religion that caused him to wait some twenty years before publishing Vacation Stories for fear of how the text's reception might negatively impact his career (Ramón y Cajal, 1999, p 100).

¹²Pratt's analysis of the kiss remains one of the most prescient (pp 89-91).

they thought they had seen ghosts—“reached its peak [paroxysm]”, a term that draws attention to their emotional disequilibrium (p 100). The next day Rivalta is in a frenzy, as the terrified women recount their experience, which for the next month becomes “the obligatory gossip of old women and idlers” (p 100). Similarly, in an earlier episode from the text, the narrator notes how Julián’s accident had unleashed the village women’s penchant for gossip: “such a common, ordinary mishap was enough to unleash the tongues of the Rivalta gossips. They exaggerated the facts and sent out dreadful horoscopes in all directions” (p 90). The loose-tongued “old women” and the paroxysmal “fisherwomen” reveal Cajal’s tendency to portray women as prone to lose control. Although the nominalized masculine adjective used for “idlers” (“desocupados”) would include men in the narrator’s criticism, the text is clear in only associating women with emotional instability¹³.

It is not just the townsfolk’s tendency to misinterpret natural phenomena as manifestations of the supernatural that the narrator criticizes; it is also their lack of pragmatism. At the local social gathering (tertulia) both Ramascón, a naturalist and retired naval captain, and Don José, the town surgeon, share Julián’s scientific outlook on life and attribute the red light of the flash emanating from Julián’s house and the contaminated land of Villa Inés to naturalistic causes. Even so, however, they are not spared from the narrator’s censure because they do not put into practice their scientific outlook. Rather, they spend the entire evenings trying to convince Don Timoteo, a Carlist, and a local spiritualist (espiritista) nicknamed Allen Kardec, of the error of their superstitious ways. Alas, they return home having completely failed: “Sadly the polemicists filed out, each one with his creed entirely intact and his hands to his head to dispel his intense headache . . .” (p 117). The narrator’s criticism of the men can be seen in the way the text juxtaposes the proverbial fruits of their labor—a headache—with the bona fide fruits of Julián’s efforts to regenerate Villa Inés. Immediately after the tertulia scene, the narrator describes the thousands of bushels of corn, rye, and wheat produced by Julián on his newly regenerated homestead, as well as the hundreds of heads of livestock roaming the land.

The juxtaposition of Julián’s success and the tertulia members’ headache indicates that regeneration in the text is a function of deeds, not ideas (or at least, not just ideas). Even when ideas reflect a scientific worldview, they must be put into practice to make a difference. It is for this reason that Julián’s absence from the tertulia is both so conspicuous and so important. While Ramascón

and Don José spend their time discussing the cause of Villa Inés’s problems, Julián sets about installing the technical equipment necessary to analyze the soil and identify and eradicate the noxious influences. Only then is he able to convert his homestead into a productive property. And it is this preference for pragmatism over speculation that distinguishes him from those who, like Ramascón and Don José, share his scientific perspective, but not his zeal for putting that perspective into practice.

The problem with the sort of speculation engaged in by the tertulia participants is that it remains disconnected from the reality it is meant to explicate. Esperaindeo’s education is similarly problematic because it divorces his book learning from the observable world. As he explains to Jaime: “I’m a poor victim of a bad education who has had his eyes opened by misfortune . . . , eyes that had never before seen the reality of things” (p 172). Steeped as Esperaindeo’s education was in metaphysics and religion, anything in the observable world that contradicted what he was taught was viewed as erroneous for being subversive to his faith. Criticizing what he calls “the essentially prophylactic method” (p 186) of his friend’s education, Jaime notes a fundamental difference with his own: “Unlike you, I studied things first, then books, so that the books illustrated things for me without implanting suggestions and distorting my way of seeing” (p 205). For Jaime, Esperaindeo’s lack of experience with, or knowledge of, natural objects (“things”) has made him vulnerable to erroneous ideas, the very ideas to which his religious education had exposed him, and which had led to his psychological crisis. By contrast, Jaime’s direct exposure to nature before receiving his book learning allowed him to weather his own crisis much more effectively. “The moral of the story,” as Pratt has argued, “is that an individual will succeed in life if left unimpeded by the education society provides” (p 86). For Cajal, education was especially problematic when it was thick on religion but thin on hands-on scientific experience.

Not only does Julián’s pragmatism distinguish him from those who, like Don José and Ramascón, otherwise share his preference for naturalistic explanations of the world, but it also marks him as ethnically different. Early in the text, the narrator describes him in the following light: “Contrary to the usual [secular] habit of the southern races, who insist on solving all problems in life by talking about them, our doctor set up a magnificent laboratory in his house” (p 82). The passage underscores Julián’s idiosyncrasy as the term “contrary” puts him at odds with “southern races” like Spaniards, and links him implicitly with northern, or Eu-

¹³For Cajal’s views on women, see his *La mujer*. Conversaciones e ideario recogidos por Margarita Nelken and María José Jiménez Tomé (Ramón y Cajal, 1932).

¹⁴On the issue of Spain as a southern race, see Fernández Cifuentes (2007, pp 133-144), Charnon-Deutsch (2004, p 15, 95, 115, 180), Wood Peiró (2012, pp 159-60), and Tofino-Quesada (2003, pp 142-143).

ropean, races¹⁴. While the "southern races" resort to "talking" to resolve life's problems, he sets about installing the crucial infrastructure that will ultimately result in high yields of crops and herds. The idea that southern races tend to resolve issues through talking presages the tertulia debate between Ramascón, Don José, Don Timoteo, and Allen Kardec. Although Ramascón and Don José reject the religious and superstitious explanations of the other two, their "usual [secular] habit" does not spare them from criticism. The passage suggests that for Cajal, secular conjecture is no better than religious ratiocination at solving social problems; both are poor substitutes for laboratories and Spain gains nothing by hiding from its problems behind sophism¹⁵.

Despite Cajal's preference for pragmatism, the narrator's criticism of the tertulia should not be taken as a wholesale dismissal of rhetoric by the author. Indeed, if Villa Inés is revived through the practical application of scientific knowledge, Inés is (re)educated through a series of letters in which Julián responds to Inés's doubts about his plans for the homestead by laying out the scientific principles and practices on which the plans are based. In this way, Cajal establishes a suggestive parallel between the regeneration of Villa Inés and the reeducation of Inés, as Inés's evolution from doubt to belief (in science) mirrors the physical transformation of Villa Inés from infested plot to thriving homestead.

The bacteriological conquest of Villa Inés thus has its analogue in the ideological conquest of Inés and, in this way, "The Accursed House" serves as an allegory for Spain as both a place (Villa Inés) and a people (Inés). The conflation of the national body with the female body specifically was significant in the nineteenth-century, as witnessed by the portrayal of Isabel II as a symbol of the nation in socio-political discourse (White, 1999, p 235). Unlike the queen, however, Inés betrays no sign of sexual deviancy, or, for that matter, a disorderly life: "[She] belonged to that privileged caste of calm, well-balanced women, healthy and robust in body and soul... In her, the tender, compassionate, most exquisitely feminine instincts of woman were combined with an energetic will, serious character, and heroic aptitude for self-sacrifice in a wonderfully harmonious union" (pp 71-72). The specific reference to Inés's equilibrium puts her at odds with the general tendency of both political discourse and nineteenth-century Spanish literature to feminize disorder (Tsuchiya, 2011, p 15). Inés seems rather to possess the ideal balance of feminine personality traits. In her study of

Isabel II as a symbol of the Spanish nation, Sarah White has identified a "triad of feminine vices" that the queen possessed which undermined the nation: "superstition, caprice, and ignorance" (White, 1999, p 241). Although Inés's problem is not one of deviance or disorder per se, she does evince both superstition and ignorance, which Julián sets out to correct.

The first exchange of letters between Inés and Julián juxtaposes their respective frames of reference in relation to the homestead and establishes the terms on which Inés's transformation will occur. Whereas she resorts to superstition to characterize the condition of the land, warning of "its harmful [maléficos] domains" (p 84), he offers a protracted explanation of the "causal conditions" in purely naturalistic terms (p 85). He thus assures her that it was microbes, and not God or the devil, that had a part to play in the demise of Villa Inés's previous owners. The first words of each letter, which the narrator transcribes for the reader, clearly distinguish between the two characters' explanatory frameworks. Inés's "For God's sake, Julián" invokes the unimpeachable authority of divinity (p 82). Moreover, the juxtaposition of "God" and "Julián" rhetorically minimizes Julián's stature in comparison to that of God. For his part, Julián's "You must convince yourself—for I have irrefutable proof of it—that the owners or tenants of the Accursed House were innocent victims" adduces the empirical evidence that allows him to take what for Inés is such a bold approach to the accursed house (p 84). The imperative "You must" clearly reveals Julián's intention to convince Inés, though the reflexive element of the sentence in Spanish indicates that she should convince herself by virtue of the evidence and not merely the words of an insistent fiancé¹⁶.

The same discursive tension can be seen in "The Natural Man and the Artificial Man" when Jaime, after recounting his life story to Esperaindeo with the obvious intention of providing him a pattern for overcoming his own psychological crisis, comments: "Now it's up to you to decide whether you want to follow this example or keep wandering [errar] the bleak moors of theology and politics" (p 240). Just as Julián's "You must convince yourself" signals his desire to convince Inés of the scientific validity of his plans, Jaime's use of the verb *errar* reveals his own hope that Esperaindeo will follow his example and abandon his religious faith, since to retain his faith would imply both being in error (*errar*) and wandering aimlessly (*errar*) through life. Here the didactic overtones of the story are most transparent, for as soon as Esperaindeo acquiesc-

¹⁵In this vein, Rodríguez Quiroga (1999) has argued that Cajal recognized "the need to become aware of our miseries, in the face of historical idealisms, prior to the construction of a solid Spanish science" (p 707).

¹⁶In his own life, Cajal rebuffed the imposition of any authority, including the scientific. It is therefore significant that Inés's response, in which she counters Julián's arguments with rhetorical questions and a plea that he accepts religion is immediately followed by a new chapter that begins with a description of Julián's success (p 87). The form of the story thus reinforces Julián's preference for empirical results over discursive arguments, a preference shared by Cajal.

es by confessing that Jaime's exhortations "made a new man of me", the story ends with Jaime offering him a well-paying job and the two literally riding off into the sunset towards Jaime's factory (p 240).

As Julián's success with curing the land increases, Inés's faith in his scientific viewpoint grows. It is, however, noteworthy that her complete conversion takes time. Like Spain at the turn of the century, she seems caught between the traditional modes of belief of her upbringing and a more modern *modus vivendi* based on scientific principles, advocated by Julián. Initially, Julián's letters manage to calm her fears, though only partially. For example, the letter in which she urges him to illuminate his understanding by the light of her redeeming faith begins with her acquiescence: "Everything you tell me may be true. I believe it, I should believe it" (p 87, my translation). Eventually, however, Inés's conversion is complete. In fact, her figurative movement from doubt to belief coincides with her physical movement from Rivalta to Villa Inés on the night of the sensational photograph. The contrast between her location inside Julián's home and that of the fisherwomen outside looking in draws attention to the ideological divide between Rivalta (traditional Spain) and Villaencumbra (modern Spain). The women outside view the flash, a clear sign of modernity, with trepidation, ultimately ascribing it to diabolical forces. Inés, meanwhile, accepts the new technology despite her initial anxiousness. In this sense, Inés's reeducation leads to her physical journey to Villa Inés, which symbolizes Spain's transition from a degenerate country to a regenerated one.

Even though Inés is ultimately convinced of the superiority of Julián's explanation of the ills affecting Villa Inés, her conversion comes at quite a cost to her subjectivity. When the fisherwomen recount their vision of the red light emanating from Julián's house, Inés's mother seizes the opportunity to try to convince Inés that Julián is wrong and the traditions of Rivalta are correct: "Don't you see, my daughter?" asked Inés's innocent, superstitious mother. "And here you were thinking that with Julián's science and foresight, he had averted the danger!" Although Inés remains impervious to her mother's insinuations, the narrator includes a subtle, though significant, detail about her relationship to Julián: "This time, though, the mournful legends of witches and ghosts did not disturb the beautiful young girl in the least. She knew very well what to believe [a qué atenerse]" (p 101). The *Diccionario de la Real Academia* includes two informative definitions of *atener*, both of which refer to a strict hierarchy that obtains between two parties. In "The Accursed House", Inés se atiene a Julián because she believes his thinking to be more sure than that of her mother, who represents the traditional way

of thinking in Rivalta. In this way, she subjects herself ("se sujeta") to him.

It is worth noting that over and against Inés's emotional handwringing, Julián never betrays even a hint of doubt about his diagnosis of Villa Inés's ills. Ultimately, the regenerated Spain idealized in "The Accursed House", despite positing an important role for women, reinforces a hierarchized gender dynamic in which woman's role is subordinated to that of man's. Although the text celebrates Inés as the ideal embodiment of feminine virtues, it also makes clear that it is for Julián to practice science and ultimately regenerate Spain, while Inés's place is to follow his lead¹⁷.

Esperaindeo's transformation comes at a similar cost to his subjectivity, as he submits to Jaime's will, declaring: "I am at your service" ("The Natural Man" p 240). The subjugation of Esperaindeo to Jaime in "The Natural Man" and the association of the town priest with the old women in "The Accursed House" offer subtle clues that Cajal viewed religion and women as immature manifestations of social and human development vis-à-vis science and men, respectively. "The Natural Man" includes a less-than-subtle assessment of religion when Jaime refers to it (and philosophy) as possessing "the logic of the necessary error, the educating error" (p 211, emphasis in the original). In other words, for Jaime, religion is necessary, but only insofar as it serves social evolution. As humanity progresses, it will naturally abandon religion in favor of science.

Despite the inequality of their relationship, Julián and Inés's union nevertheless plays a fundamental role in Cajal's vision of modern Spain. The narrator describes their relationship in glowing terms: "And they married..., and were happy..., and had strong, beautiful, intelligent children..., And the loving couple made the long journey to old age without suffering any eclipses of their sweet, loyal feeling for one another, or of their serene joy" (p 121). Discursively, the ellipses in the passage skip over abundant details of the couple's story. With this lack of narrative detail, Cajal suggests a concomitant lack of marital problems. What is more, their individual happiness has broader social implications. Indeed, embodying as they do the hygienic matrimones advocated by eugenics in the early twentieth century (Sosa-Velasco 2010, p 28), the story establishes a metaphorical parallel between "the social body (the family formed by Inés and Julián) and the national body (Spain)" (p 33). In other words, the couple is modern Spain's model family, and their union provides a pattern for others to follow. The implication of Cajal's narrative logic is that, if others do follow the example of Julián and Inés, they will be contributing to national regeneration. The exemplarity of Julián and Inés's

¹⁷In this way, Cajal's treatment of Inés reveals an important limit to his utopian view of regenerated Spain. The subordination of women is even more explicit in other stories from *Vacation Stories*, for example, "The Fabricator of Honor" and "For a Secret Offense, Secret Revenge".

relationship can be appreciated more fully by contrasting it with the dysfunctional marriage between Esperaindeo and Magdalena.

After Esperaindeo's family loses everything in the stock market and at the hands of a dishonest business partner, his father dies and Esperaindeo finds himself in the position of needing to provide for his family. He does so by setting up a law practice, which fails to make a profit, however, and his mother decides to marry him to a rich heiress. Unfortunately, the marriage proves a disaster as Magdalena, after a tumultuous period together, cashes in her dowry in government bonds and flees the country "with a little romantic dandy" (p 193). Esperaindeo's misfortune with Magdalena serves as a cautionary tale to those who would depart from the model of matrimony offered by Julián and Inés. Despite Magdalena's ostensible religiosity, she spends money thriftlessly and disdains Esperaindeo. When Esperaindeo's mother chastises her for her behavior, she explodes in hysterical rants. Esperaindeo admits "I should have taken charge of the situation, making myself the effective head of household and administrator of my wife's estate", but blames his weak character and an imperfect understanding of dignity for not taking control of the situation. In contrast to the hygienic marriage exemplified by Julián and Inés, Esperaindeo and Magdalena fail to conform to their proper roles as husband and wife, respectively. Not surprisingly, then, during their domestic quarrels, Esperaindeo sensed in his wife "a virile will quivering behind that frivolous soul, hostile to the interests of our home" (p 193). Magdalena essentially usurps the dominant, masculine role in the relationship, while Esperaindeo accepts the passive role usually reserved for the wife in late nineteenth-century Spain, and the disastrous outcome can be traced directly to this perversion of the proper social and natural order.

Although critics have recognized the symbolic importance of Julian and Inés's romance, the crucial role played by technology in the scene of the photographic flash has received less attention. Indeed, by narratively combining the technology of the flash with the protagonists' kiss, Cajal effectively casts the issue of Spanish modernity in terms of romance¹⁸. While it is true that the couple will go on to have children, the scene of the kiss deals with technological as much as biological reproduction, framing as it does the revelation of the photograph as a sexual encounter. Indeed, the association of technology with biology in the same scene is key to understanding the significance of "The Accursed House" as a foundational fiction of modern Spain. A sustained analysis of the pas-

sage is thus in order:

"Come with me, little girl [hija mía]," replied Julián, "to the darkroom . . . We'll develop this film [cliché] . . . and you'll know the supreme pleasure of witnessing a true act of creation, . . . the formation of a being who is progressively revealed from the chaos of gelatin just as the first man must have arisen from the sublime Fiat Lux of the Creator."

Seizing the young woman's hand—for she had now calmed down considerably—he led her to the darkroom, where he readied the solutions necessary to develop the image.

While our pleasant young lovers develop their virginal film in silver bromide (*hony soit qui mal y pense*), permit the author to indulge in a lyrico-biological digression. (p 97, ellipsis in the original)

The text's language imbues the scene, which is ostensibly about developing film, with blatant sexual overtones. The process of development becomes an act of creation that produces a "being", which is also described as an image. In this sense, Julián and Inés's offspring represents the image of the modern Spaniard. "We'll develop this film" and "develop their virginal film" function as double entendres referring both to the developing process and to sexual intercourse. Moreover, the act of creation is described as being particularly pleasurable ("supreme pleasure").

The narrator's pseudo-reprimand for recognizing the sexual overtones of the passage only reinforces this particular reading of the text. "*Hony soit qui mal y pense*", which roughly translates as "Shame on anyone who has bad thoughts about this" is little more than a wink to readers that draws attention to the prurient tenor of the prose¹⁹. Furthermore, the narrator's "lyrico-biological digression" that follows the citation, and which happens to coincide with Inés and Julián's revelatory encounter, amounts to a panegyric on love, punctuated by numerous exclamation points. The thrust of the narrative thus establishes a clear parallel between the narrator's exultations of love and the couple's enactment of these exultations. Offering further evidence of the sexual implications of the passage, Cajal juxtaposes Julián's reference to Inés as "little girl" (literally "my daughter") with the narrator's phrase "young woman", thus insinuating a process of sexual maturation. Inés transforms from a girl into a woman, though one without carnal knowledge, a point reinforced by both the term "young woman" (*doncella*) and the mention of "virginal film". The narrator's choice of the ambiguous verb *seize* (*coger*), however, and the fact that Julián leads her into a dark room where he reproduces with her a being, both point to her loss of

¹⁸On the importance of romance for national identity in the Latin American context, see Sommer (1991).

¹⁹Cajal employs insinuating rhetoric in a related scene from "For a Secret Offense, Secret Revenge". In the story, Max von Forschung, fearing his wife is cheating on him with his lab assistant, rigs up a seismographic apparatus to the couch in his laboratory hoping to catch the two in flagrante. Sure enough, he returns to the office one evening to find a graphic printout from the machine whose peaks and valleys bear condemning witness to the particularities of his wife's infidelity (pp 9-10).

virginity. The lyrico-biological digression that follows serves to confirm Inés's transformation from a girl into a woman, the culmination of which is her sexual encounter with Julián.

Significantly, then, the scene that sees Inés steal away at night to Julián's house is doubly climactic, representing her symbolic journey both from religious traditionalism to scientific enlightenment and from virginal girl to sexually experienced woman. In fact, in light of the allegorical nature of "The Accursed House", I would argue that Inés's personal journey symbolically projects Spain's evolution from a backwards to a modern nation. Part of being a modern nation, the text suggests, means letting go of old-fashioned beliefs and adopting a scientific worldview. It is worth noting in this sense that the text presages the sexual conquest of Inés in her first letter to Julián, in which she uses sexually suggestive language to implore him not to undertake his regenerationist enterprise: "don't move into the Accursed House or enter [penetrar] its harmful domains" (p 84). The ambiguous penetrar linguistically links Julián's bacteriological reconquest of Villa Inés to his sexual conquest of Inés, the imposition of scientific principles, in one case, and the conversion of Inés to a scientific worldview, in the other.

Julián's explicit evocation of the biblical creation story ("the sublime Fiat Lux of the Creator") only serves to augment the significance of the scene, endowing it with the aura of myth and making it the fulcrum on which Cajal's vision of modern Spain pivots. The mythic element of the passage helps explain the multiple relationships that obtain between Julián and Inés, including the frisson of incest ("hija mía"), as it is in the passage that the conceptual difference between the two as characters and as symbols of modern Spain practically disappears. At one level, the two characters simply engage in sexual intercourse as lovers. At a more symbolic level, however, Julián qua modern scientist is the father who gives birth to Inés, his daughter, who matures into his lover and with whom he reproduces the new being. Inés thus becomes the madre patria (literally the mother fatherland) and this new being symbolizes modern Spaniards. The encounter between Julián and Inés does not merely recreate the biblical account of the creation, however. They are not recuperating a lost Eden, but creating a new paradise, modern Spain.

This new version of Spain maintains a peculiar relationship to the traditional version it replaces, especially in terms of religion and gender. On the one hand, Inés does not serve the same purpose as women in modernist fiction, who "became a national symbol and guardian of the continuity and immutability of the nation" (Johnson, 2003, p 21). Rather, her conversion to Julián's scientific

worldview, and her concomitant abandonment of religion, reflects the social evolutionary process Jaime discusses in "The Natural Man". On the other hand, the passage, and indeed the entire story, does evince the notion that "anxieties about the Spanish nation and its imperial status translated into an overarching preoccupation with questions of gender and sexuality" (Tsuchiya, 2011, p 4). Although the text advocates a view of modern Spain that is non-religious, it is nevertheless a Spain that remains grounded on a heterosexual foundation marked by traditional gender norms²⁰.

To understand fully how Cajal figures modern Spain in "The Accursed House", it is necessary to consider the collusion between technological reproducibility and myth in the passage of the photograph and the flash. In his influential essay, "The Work of Art in the Age of Mechanical Reproduction", Walter Benjamin (1969) ruminates on the consequences of photography and film. For him, the decline of artistic "aura", which is related to the authenticity and, thus, authority of a given work of art that is not mechanically reproduced, stems from two related processes. Firstly, "the technique of reproduction detaches the reproduced object from the domain of tradition" (p 221). Secondly, "in permitting the reproduction to meet the beholder or listener in his own particular situation, it [i.e., the technique of reproduction] reactivates the object reproduced" (p 221). Ultimately, the loss of artistic aura fundamentally alters the function of art: "Instead of being based on ritual, it begins to be based on another practice—politics" (p 224). In a related sense, Roland Barthes (1972) links myth to politics, in the form of (bourgeois) ideology, in his *Mythologies*. For Barthes, myth distorts by "postulat[ing] a kind of knowledge, a past, a memory, a comparative order of facts, ideas, decisions" (p 117). In other words, myth presents its own (distorted) view of history as natural in order to advance specific ideological objectives.

In "The Accursed House", the photograph of Julián and Inés, as a metonymy for the technique of reproduction, detaches the couple from any aura of authenticity. Cajal's point is not so much that they are an original couple, compared to which all subsequent Spanish couples will be judged to be inferior copies, but, rather, that they are a model to be copied. By meeting readers in their own situation, the story encourages them to identify with Julián and Inés. If Spaniards imitate them by engaging in practical science like Julián, and adopting a scientific worldview like Inés, then the film ("cliché") they will collectively reveal will be nothing less than a modern, regenerated Spain (p 135). In this way, the text accomplishes the ideological objective of (re)constructing modern Spanish identity on the marriage of technology (as a sign of mod-

²⁰On the relation between gender and the nation, see White (1999, p 233-249), Tsuchiya (2011, pp 139-143, 146-148), Johnson (2003, pp 31-68), and Labanyi (2007, pp 31-51, 91-138)

ernization) and love. It is technology, in the form of "a magnificent laboratory in his house for bacteriological, histological, and chemical analysis" that allows Julián to gain fame and fortune in Mexico (p 82). And it is technology that grants him similar success upon his return to Spain. However, technology always serves the purpose of enhancing rather than replacing (human) life. Thus, at the end of "The Accursed House", the widowed Julián pulls out the picture of his and Inés's kiss to celebrate not the technology of photography, but the "sight of that sublime picture" that the technology had afforded (p 121).

Julián's reminiscences at the end of "The Accursed House" give the story a suggestive symmetrical structure. The beginning, middle, and end of the text all deal specifically with Julián and Inés's relationship. The story opens with Inés excitedly sharing Julián's recently arrived letter from Mexico with her family. It ends with Julián waxing nostalgic about the happy life he and Inés had shared. And situated exactly in the middle is the scene of their photographed kiss. Julián and Inés's symbolic union occurs at the mid-point of the story, which not only gives the passage a certain aesthetic appeal, but also formally reinforces the importance of the scene as the hinge on which Cajal's myth of modern Spain turns.

As Dale Pratt (2001) has noted, a major theme of the Vacation Stories is "late-nineteenth-century unease about the limits of knowledge, especially knowledge about the phenomenon of love: whatever our understanding of chemistry and biology, science cannot explain love" (p 81). However, whereas Pratt focuses on Cajal's narrative struggle with the limits of language to explain life and love, I would highlight the centrality of the marriage of technology and love in Cajal's myth of modern Spain. When all is said and done, "The Accursed House" presents us with Cajal's allegory of Spanish regeneration, a regeneration that is a function of both elements in this metaphorical marriage.

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