Joined in neuroscience: romantic and professional partnerships

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ABSTRACT

In 2014, married neuroscientists May-Britt Moser and Edvard Moser, along with John O'Keefe, were awarded the Nobel Prize in Physiology or Medicine for their discoveries of cells that constitute a positioning system in the brain. Modern and contemporary history offers several examples of couples who worked on joint projects in the field of neuroscience. However, in many cases, and depending on the times they lived in, women were relegated to a supporting role whereas scientific and social recognition was accorded to their male partners. This study presents the lives of Anna Morandi Manzolini (1716-1774), Augusta Déjerine-Klumpke (1859-1927), Cécile Vogt-Mugnier (1875-1962), and Berta Vogel Scharrer (1906-1995), four women who pursued their dreams despite a host of social, political, and academic obstacles, and whose contributions were at least equal to those of their spouses. We will also mention Pearl Sowden Papez (1906-1995), whose research in partnership with her husband James Wenceslas Papez is less well-known.

KEYWORDS
Neuroscience, Anna Morandi Manzolini, Augusta Déjerine-Klumpke, Cécile Vogt-Mugnier, Pearl Sowden Papez, Berta Vogel Scharrer

Introduction

On 7 December 2014, May-Britt Moser and Edvard Moser, along with John O'Keefe, were awarded the coveted Nobel Prize in Physiology or Medicine for their studies on the positioning system of the brain, which plays a key role in spatial orientation. The Mosers are not the only case of a couple being awarded the Nobel Prize for their contributions to science. The best known example is of course that of Pierre and Marie Curie. One of their daughters, Irène Curie, and her husband, Fréderic Joliot, were awarded the 1935 Nobel Prize in Chemistry for their studies on the synthesis of new radioactive elements. Carl and Gerty Cori provide another example; these scientists received the Nobel Prize in Physiology or Medicine in 1947.

In *Advice for a young investigator* (1913), Santiago Ramón y Cajal states:

> We have observed with great admiration (and more than a little envy) those happy couples in select laboratories that are eagerly dedicated to the same work, each of them pouring into it the very finest of their mental abilities and technical skills....The images of three admirable couples come to mind. Joseph Dejerine and Augusta Dejerine-Klumpke of Paris are dedicated to studying the normal and pathological anatomy of the cerebrum; Jean and Mme. Nageotte, also of Paris, are involved in histological and neurological research; and finally, the wedded pair Oskar and Cécile Vogt of the Berlin Neurobiological Institute are involved in the vast undertaking of mapping out the architecture of the cerebral cortex, like astronomers who pass their lives absorbed in photographing and cataloguing stars and nebulae.[1]

Despite Ramón y Cajal's idealised view, the history of neurosciences pays unequal tribute to the members of these couples, acclaiming men and overlooking their wives' contributions. The purpose of this study is to review the histories of some of these women.

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Anna Morandi Manzolini

Anatomy was the most ground-breaking discipline of 18th century medicine, and anatomical wax models constituted one of the most important teaching tools in universities. The Italian painter and sculptor Ercole Lelli created outstanding models for the Istituto delle Scienze in Bologna, in cooperation with Giovanni Manzolini. Differences between these two artists led Giovanni to separate from his master and create his own anatomical models.[2]

Anna Morandi was born in Bologna in 1716 and grew up in a family that regarded marriage, childrearing, and housework as the natural path for women. In 1740, she married Giovanni Manzolini and the couple had six children. A few years after their marriage, Giovanni became ill with tuberculosis and fell into a severe depression; Anna then decided to help him with his work. Thanks to the artistic knowledge she had acquired under Giuseppe Pedretti and Francesco Monti and to her skill in dissecting cadavers, Anna became an excellent anatomical modeller. Once he had recovered, Giovanni returned to work, and he and his wife formed a superb team that was recognised by artists, intellectuals, and anatomists throughout Europe.[3] The treatises created by the Manzolini couple had a huge impact on the development of the study of anatomy in their time. Although their notes do not mention brain anatomy explicitly, Giovanni and Anna's work continues to be a model for contemporary neuroscience.[4]

After Giovanni died in 1755, the Senate of Bologna, at the behest of Pope Benedict 14th, appointed Anna Morandi as an official modeller and anatomy demonstrator at the University of Bologna.[5] Her fame as an artist stretched beyond the walls of her city. She was invited to give presentations at numerous European universities; renowned scientific societies, such as the Royal Society of London, requested her anatomical models. She was also recognised by such prominent figures as Holy Roman Emperor Joseph II and Catherine the Great. Anna Morandi Manzolini died in 1774 and was buried in the Church of San Procolo, in Bologna. The inscription on her gravestone describes her as a loving wife and mother, a research artist, and a brilliant professor. Some of her extraordinary anatomical models are exhibited in the Istituto di Anatomia Umana Normale at the University of Bologna.

Augusta Déjerine-Klumpke

Augusta Klumpke was born on 15 October 1859 in San Francisco. Her father, Johan Gerard Klumpke, moved from Suttrup, a British possession on the Continent, to San Francisco during the gold rush and became a successful businessman. Her mother, Dorothea Mathilda Tolle, was born in New York and moved to San Francisco during the 1850s. They were married on 28 October 1855 and had six children: Anna-Elizabeth (1856), Augusta (1859), Dorothea (1861), Mathilda (1863), John William (1868), and Julia (1870). They divorced in 1871, and in April of the same year Dorothea Mathilda moved to Europe with her children. In October 1877, after spending a few years in Germany and Switzerland, they moved to Paris, where Augusta began studying medicine.

Between 1877 and 1880, while at medical school, Augusta also took several science courses at La Sorbonne. She audited clinical demonstration sessions at different hospitals in Paris, and worked in laboratories including that of professor Frény in the Musee d'Histoire Naturelle. During the 1878-1879 academic year, she studied anatomy under Joseph Auguste Fort, and in the 1879-1880 and 1880-1881 academic years she worked as his assistant in his laboratory. Although female medical students were not allowed to work at public hospitals, in 1880 Augusta started to work as an intern in the service of professor Alfred Hardy at Hôpital de la Charité, in Paris. Here she was responsible for examining patients, conducting autopsies, and performing some histological studies. In addition, she translated and summarised scientific articles written in English and German, which substantially increased the bibliographical sources for the studies conducted by Hardy and his colleagues.[6] While working for professor Hardy, she met Joseph Jules Déjerine. Joseph was deeply impressed by Augusta's personality and skill. In a letter he wrote to Augusta's mother, he stated: "she is working for me, and the more I see her, the more convinced I am that she is the woman I need".[7,8]

Despite social and academic opposition, Augusta was authorised in 1882 to conduct an externship at a hospital in Paris. Five years later, she became the first woman to hold an internship (*interne des hôpitaux*) at a hospital in the French public healthcare system.[9] During these formative years, Augusta researched lower brachial plexus palsy. In 1885 she published 'Contribu-

tion à l'étude des paralysies radiculaires du plexus brachial' in *La Revue de Médecine*; this study was awarded the Goddard prize by the Académie de Médecine in 1886. After defending her doctoral thesis in 1889, she married Joseph Jules Déjerine and left her career. According to Lecours and Caplan, the rationale behind her decision was to avoid direct competition with Déjerine.[10] For years, she staunchly supported her husband and played an important role in the so-called 'aphasia debate' between Déjerine and Pierre Marie, his successor at Hôpital de la Pitié-Salpêtrière. Mr and Mrs Déjerine also brought to light one of the classics of neurology, *Anatomie des centres nerveux* (1895). According to André Thomas, it is virtually impossible to identify the parts written by one or the other.[11] Nonetheless, it is clear that Augusta was responsible for the microscope slides and a great number of the illustrations appearing in the book.

Between 1885 and 1926, Augusta Déjerine-Klumpke published 56 scientific articles. She was a founding member of the French Society of Neurology and served as its president between 1914 and 1915. During World War I, Augusta and her husband cared for the wounded at Hôpital de la Pitié-Salpêtrière. Upon the death of Joseph Jules Déjerine in 1917, Pierre Marie took his place at Hôpital de la Pitié-Salpêtrière. Augusta left the hospital and became head of a service at Hôtel National des Invalides, in Paris, which provided care to soldiers with spinal injury. Madame Augusta Déjerine-Klumpke died on 5 November 1927 at her home in Boulevard Saint-Germain, Paris, and was buried next to her husband in Cimetière du Père Lachaise.

Cécile Vogt-Mugnier

Augustine Marie Cécile Mugnier was born in Annecy (Haute-Savoie, France) on 27 March 1875. At the age of 18 she began studying medicine in Paris. Her interest in research and her remarkable intellect led Pierre Marie to offer her a position with his team at Hôpital de Bicêtre, in Paris. In early 1898 she met Oskar Vogt, a young German doctor who was training with Joseph Jules Déjerine at Hôpital de la Pitié-Salpêtrière. They married a year later and had two daughters, Marthe

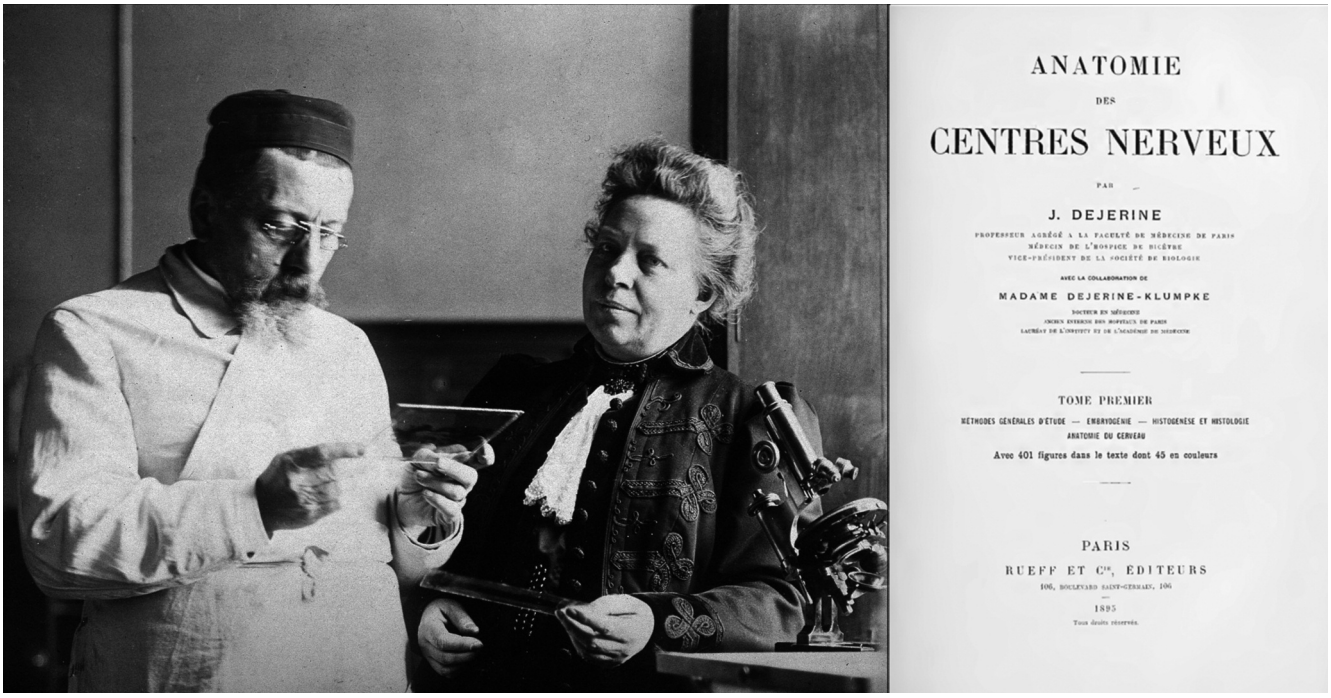

Figure 1. Left: Joseph Jules Déjerine and Augusta Déjerine-Klumpke in their laboratory (Pavillon Jacquart, Hôpital de la Pitié-Salpêtrière). Right: cover of *Anatomie des centres nerveux* (1895 edition)

(1903) and Marguerite Vogt (1913). In 1900, Cécile defended her doctoral thesis 'Étude sur la myélinisation des hémisphères cérébraux'. Despite her promising future in the field of neurology, both as a clinician and a researcher, Cécile decided to move to Berlin to fulfil Oskar's dream of creating a neurological research institute.[12]

In 1899, thanks to funding from the Krupp family, Oskar created the Neurologische Zentralstation. Three years later, this centre came under the administration of Friedrich-Wilhelm University of Berlin, becoming the Neurobiologisches Laboratorium, and subsequently gained the status of a Kaiser Wilhelm Institut in 1916, under the name Kaiser Wilhelm Institut für Hirnforschung. In the early 1930s, funding from the Rockefeller Foundation made it possible for Oskar to constitute a large research centre. This ground-breaking institute took a comprehensive approach to the study of brain structure and function (anatomy, physiology, genetics, etc.). It also had an hospital ward with beds for 60 patients.

The political changes in Germany during the 1930s had a negative impact on the activity of this new institute. The elections held on 14 September 1930 marked the end of the Weimar Republic and the onset of Adolf Hitler's unstoppable rise to power. Pressure from the totalitarian regime of Nazi Germany forced Mr and Mrs Vogt to leave the Institute. In 1937 they moved to Neustadt, a small town near Freiburg, where further support from the Krupps enabled them once again to continue their work at the Institut für Hirnforschung und Allgemeine Biologie.[13]

Although Cécile's scientific activity was linked to that of her husband for more than fifty years, she did unpaid work until 1919, when she drew her first salary as department head at Kaiser Wilhelm Institut für Hirnforschung. She reached the summit of her scientific success in 1932 when she became a member of the Deutsche Akademie der Naturforscher Leopoldina, founded in 1652 and considered the oldest scientific society in the world. After Oskar's death, she moved with her daughter Marthe to Cambridge, England, where she died in 1962.[14]

Cécile and Oskar were two of those people who seem to have been born ahead of their time; their scientific, political, and social ideas were far more progressive than those of their contemporaries. As a result, they occasionally found themselves in ridiculous situations. For example, Cécile and Oskar submitted a paper for presentation at the annual meeting of the Medical Society of Berlin in 1900. Although the paper was accepted, Cécile was not permitted to attend: according to the Society's by-laws, women were not allowed in their meetings.[13]

Pearl Sowden Papez

The contribution made by Pearl Sowden Papez to the neurosciences is by no means comparable to those of Anna Morandi Manzolini, Augusta Déjerine-Klumpke, or Cécile Vogt-Mugnier. However, she deserves recognition for her invaluable contributions to her husband's work.

Little is known about the life of Pearl Sowden. According to the 1930 US census, she was born in Minnesota in 1882. She married James Wenceslas Papez on 31 May 1912 and had three children, James Pitney (1917), Julia (1922), and Loyd (1922). At the time the census was taken, Pearl was working as a teacher at a public school in Ithaca, New York,[15] where James Papez spent the greater part of his career as a professor at Cornell University.

In 1929, James published *Comparative neurology: a manual and text for the study of the nervous system of vertebrates*, which featured Pearl's illustrations. Pearl, who had studied art, collaborated with her husband by illustrating anatomical structures observed under the microscope. The excellent drawing included in the well-known article 'A proposed mechanism of emotion' (1937) was also Pearl's work (Figure 2).[16] In 1949, the family moved to Columbus, Ohio, where James was appointed director of the Laboratory for Biological Research at Columbus State Hospital. In the articles published during this new stage in his career, Pearl is credited as a laboratory assistant.[17,18]

On 13 April 1958, while having breakfast with his wife, James experienced sudden substernal chest pain and died shortly thereafter of acute myocardial infarction. Pearl moved to California, where the couple had bought a small house for their retirement. She died on 16 January 1969 in her eldest son's house in Lancaster, Pennsylvania. Her remains were laid to rest beside her husband in Galloway, Ohio.[19]

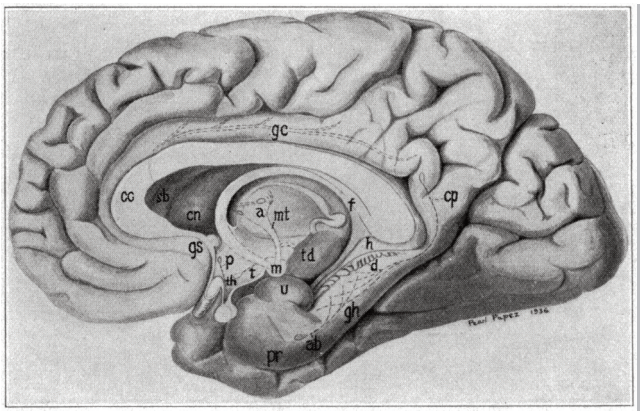

Figure 2. Medial view of the right hemisphere of the brain. Illustration by Pearl Sowden Papez

Berta Vogel Scharrer

Berta Vogel was born on 1 December 1906 in Munich, Germany, to Johanna Weiss Vogel and Karl Phillip Vogel. Her father, a judge and vice-president of the federal court of Bavaria, appears to be linked to Hitler's imprisonment in 1924 for high treason following his failed coup d'état. Berta, who had been interested in science since she was a child, enrolled in the University of Munich and studied the behaviour of bees in the zoology department under Karl von Frisch, who was awarded the Nobel Prize in Physiology or Medicine in 1973. It was in professor von Frisch's laboratory of that she met her future husband, Ernst Scharrer.[20,21]

In 1934, Ernst became the director of the Edinger Institute for Brain Research, in Frankfurt-am-Main; the young couple got married shortly afterwards. At the Edinger Institute they developed the concept of neurosecretion and laid the groundwork for a new field of study: neuroendocrinology. Ernst and Berta worked together for more than thirty years, until Ernst tragically died in Miami Beach, Florida, in 1965. Although Berta had a place of her own at the Edinger Institute where she could perform her research, the regulations at that time did not allow her to have an academic position or receive a salary for her work. In an interview published in 1989, Berta stated: "An academic career at that time did not look promising at all for a woman. I must say that I could not have done what I have if I had not been married to a biologist who gave me a chance to do my work."[22]

Adolf Hitler's rise to power ushered in major political and social changes in Germany. The Scharrers were ideologically opposed to the Nazi regime. In 1937, Ernst received a grant from the Rockefeller Foundation to work at the University of Chicago. The couple moved to the USA and never returned to their native Germany. In Chicago, Berta once again worked as an assistant researcher but received no salary. The same was true when Ernst was hired by Case Western Reserve University. The latter institution was dominated by men and markedly hostile toward women who attempted to take part in it. Berta was allowed to attend department seminars on the condition that she make the tea for the faculty.[22]

In 1955, Ernst accepted a high-ranking academic position at Albert Einstein College of Medicine at Yeshiva University, in New York. To Berta's surprise, the dean of the school offered her a paid, full professorship; this was the first time Berta had held an academic position. However, Berta's contract stipulated that she would receive half her salary while her husband lived.[23] Ernst's death in 1965 marked a turning point in Berta's career, partly because her valuable contributions to science were finally recognised by the scientific community and some government institutions. She became a member of the National Academy of Sciences in 1967 and the Deutsche Akademie der Naturforscher Leopoldina five years later. She served as president of the American Association of Anatomists from 1978 to 1979 and was appointed honorary member of numerous scientific societies. In 1985, she was awarded the National Medal of Science, the highest scientific honour awarded in the United States. Berta Vogel Scharrer died on 23 July 1995 in her home in the Bronx, New York.

Final comments

The history of neuroscience has mainly been shaped by the contributions of men, with women playing a more discreet part. This study provides a brief outline of the lives of five women who, proceeding from different fields and at different times, all contributed to the history of neuroscience. They also have a common denominator: they were married to men who shared their interest for neuroscience, which resulted in their professional lives being overshadowed by their male partners.

Conflicts of interest

The authors have no conflicts of interest to declare.

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