

Duchenne De Boulogne: A Pioneer in Neurology and Medical Photography

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ABSTRACT: Guillaume-Benjamin-Amand Duchenne was born 200 years ago in Boulogne-sur-Mer (Pas-de-Calais, France). He studied medicine in Paris and became a physician in 1831. He practiced general medicine in his native town for about 11 years and then returned to Paris to initiate pioneering studies on electrical stimulation of muscles. Duchenne used electricity not only as a therapeutic agent, as it was commonly the case earlier in the 19th century, but chiefly as a physiological investigation tool to study the anatomy of the living body. Without formal appointment he visited hospital wards across Paris searching for rare cases of neuromuscular disorders. He built a portable electrical device that he used to functionally map all bodily muscles and to study their coordinating action in health and disease. He gave accurate descriptions of many neuromuscular disorders, including pseudohypertrophic muscular dystrophy to which his name is still attached (Duchenne muscular dystrophy). He also invented a needle system (Duchenne's histological harpoon) for percutaneous sampling of muscular tissue without anesthesia, a forerunner of today's biopsy. Duchenne summarized his work in two major treatises entitled *De l'électrisation localisée* (1855) and *Physiologie des mouvements* (1867). Duchenne's iconographic work stands at the crossroads of three major discoveries of the 19th century: electricity, physiology and photography. This is best exemplified by his investigation of the mechanisms of human physiognomy in which he used localized faradic stimulation to reproduce various forms of human facial expression. The album that complements his book on this issue is considered a true incunabulum of photography. Duchenne de Boulogne, a shy but hard-working, acute and ingenious observer, became one of most original clinicians of the 19th century. He died in Paris in 1875.

RÉSUMÉ: Duchenne de Boulogne : un pionnier de la neurologie et de la photographie médicale. Guillaume-Benjamin-Amand Duchenne naît à Boulogne-sur-Mer (Pas-de-Calais, France) en 1806. Il obtient son diplôme de médecine à Paris en 1831 et retourne dans sa ville natale où il œuvre à titre de praticien général. Il revient à Paris en 1842 afin d'y effectuer des travaux sur la stimulation électrique des muscles. Il utilise alors l'électricité non seulement comme moyen thérapeutique, comme c'était le cas depuis le début du XIXe siècle, mais surtout comme instrument d'investigation de l'anatomie du vivant. Il invente un stimulateur électrique portable dont il se sert pour établir une cartographie fonctionnelle de l'ensemble des muscles du corps, tant chez les individus sains que chez des patients atteints de diverses pathologies neuromusculaires. Il nous donne une description détaillée de plusieurs de ces maladies, dont la dystrophie musculaire pseudo-hypertrophique à laquelle son nom est toujours attaché. Il met au point son fameux emporte-pièce qui permet de prélever une partie du muscle (biopsie) pour analyse histologique et fait construire de nombreuses orthèses et prothèses pour faciliter le déplacement des patients souffrant de maladies neuromusculaires. Il résume ses principales découvertes dans deux traités majeurs : *De l'électrisation localisée* (1855) et *Physiologie des mouvements* (1867). Le travail iconographique de Duchenne se situe à l'intersection de trois découvertes majeures du XIXe siècle : l'électricité, la physiologie et la photographie, et son étonnant ouvrage sur la physiologie des émotions (1862) en est un exemple frappant. L'album accompagnant ce traité est un véritable incunable de la photographie. Médecin solitaire et chercheur acharné n'ayant jamais bénéficié de poste académique, Duchenne devient l'un des cliniciens les plus originaux du XIXe siècle. Il meurt à Paris en 1875.

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Guillaume-Benjamin-Amand Duchenne (Figure 1) was born on September 17, 1806, in Boulogne-sur-Mer (Pas-de-Calais) in the Northern part of France. He descended from a family of fishermen and sea captains established in this harbor city since the first half of the 18th century. His father was the commander Jean-Pierre-Antoine Duchenne (1767-1826), who received the *Légion d'honneur* from Napoléon Bonaparte (1769-1821) in 1804 for his role as a corsair during episodic wars with the English fleet.¹⁻³ His son Guillaume decided to break away from this prestigious seafaring tradition by choosing to go into medicine. Educated in a highly religious environment, he obtained his *bacalauréat ès lettres* from Bishop Haffreingue's college at Douai in 1825 at age 19. He then started to study

medicine in Paris in 1827 under teachers as prestigious as the surgeon Guillaume Dupuytren (1777-1835) and the anatomopathologist Léon-Jean-Baptiste Cruveilhier (1791-1874). He graduated in medicine in 1831 after defending a short and rather uninspired thesis dealing with burns. Because of his father's death, Duchenne was anxious to return to Boulogne to

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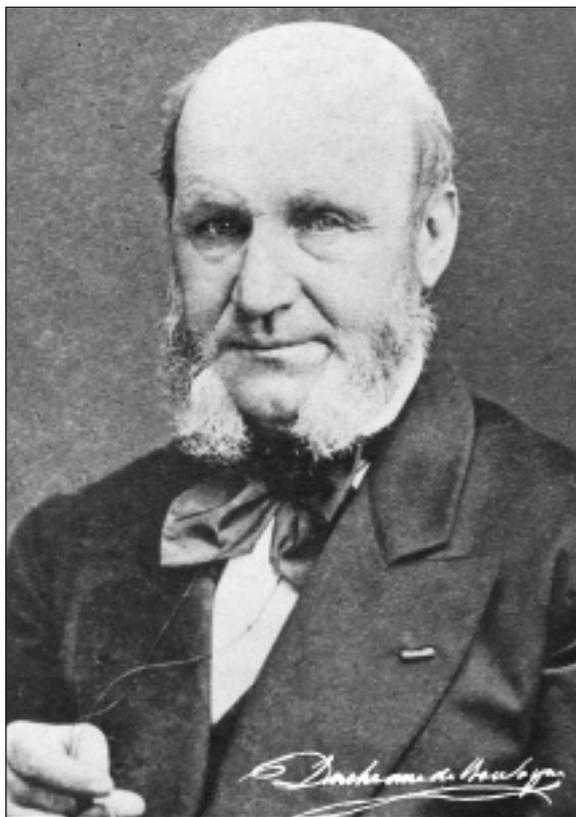


Figure 1: Duchenne de Boulogne in his early 60's. The portrait was kindly provided by Mrs. Véronique Leroux-Hugon, Head of the Charcot Library [SCMD, Université Paris VI] at la Salpêtrière, Paris. Duchenne's signature was taken from an inscription found on a copy of Duchenne (de Boulogne) GBA. *De l'électrisation localisée*, Paris, Baillière, 1872, located at the main library of the Muséum National d'Histoire Naturelle of Paris and dedicated to Professor Chevreul [the famous French chemist Michel-Eugène Chevreul (1786-1889)]. It was electronically imported onto the portrait.

support his family. He rapidly became a prosperous physician and married, in 1831, Barbe Boutroy, a young lady of Boulogne-sur-Mer.² Unfortunately, his wife died of puerperal sepsis in 1834 shortly after having given birth to their son Guillaume-Maxime. Because Duchenne was himself involved in the child delivery, his mother-in-law held him responsible for the death of her daughter and took over the upbringing of Guillaume-Maxime, to whom he remained estranged for many years. In 1839, he married Honorine Lardé, a young widow and a distant cousin, whose extrovert personality differed radically from that of her quiet, secluded and rather absent-minded husband.²

Soon after his second marriage, Duchenne became interested in electropuncture, a procedure developed by François Magendie (1783-1855) and Jean-Baptiste Sarlandière (1787-1838) to improve acupuncture with the help of electricity. Duchenne had already tried electric stimulation in a patient suffering from neuralgia back in 1835 and, from then on, he became literally fascinated by the issue of medical electricity. He designed a procedure that used portable machines composed of an induction coil and two humid surface electrodes (Figure 2A,C). By greatly

reducing the spread of electric current, these instruments allowed him to stimulate single muscles, while avoiding tissue damage and pain associated with electropuncture. Armed with this novel technical approach, which he called *électrisation localisée* (localized faradization), Duchenne returned to Paris in 1842 to start a new career in clinical electrophysiology.

A LONG AND DIFFICULT EMERGENCE

Without the support of influential clinicians, it was nearly impossible for a provincial family doctor like Duchenne to become a well-established physician in Paris in mid 19th century. Hence, alone and without funds and formal appointment, Duchenne had to work very hard in charity clinics and hospitals to gain his livelihood. In the words of the neurologist Edouard Brissaud (1859-1909): "His battery and induction coil (*sa pile et sa bobine*) were his modest and major capital, but he had inexhaustible reserves of confidence, independence and courage."⁴

Duchenne, a man of medium height, thickset, active in movement, slow in speech and retaining to the last a faint provincial accent,¹ added the epithet *de Boulogne* to his name to

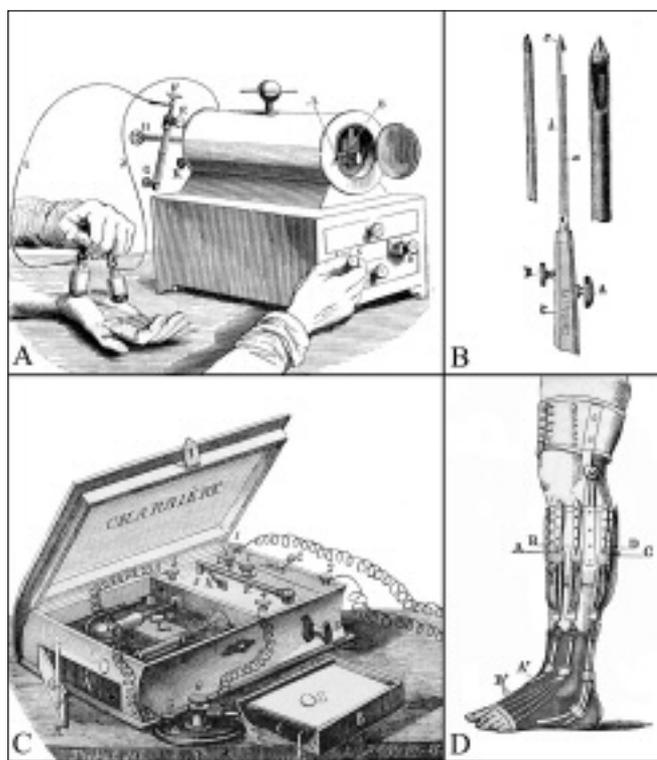


Figure 2: Duchenne on technology. A: a diagram showing how to handle with one hand the two electrodes attached to the large version of Duchenne's electrical stimulation apparatus. B: the biopsy needle (harpoon) developed by Duchenne for muscle biopsies. C: a small, book-sized, version of Duchenne's electrical faradization apparatus. D: example of a prosthesis designed to help patients suffering from foot muscle paralysis. Charrière, a Parisian manufacturer of medical equipment, constructed most of Duchenne's instruments. All illustrations are from the author's copy of Duchenne (de Boulogne), GBA. *De l'électrisation localisée*, 3rd edition. Paris: Baillière, 1872.

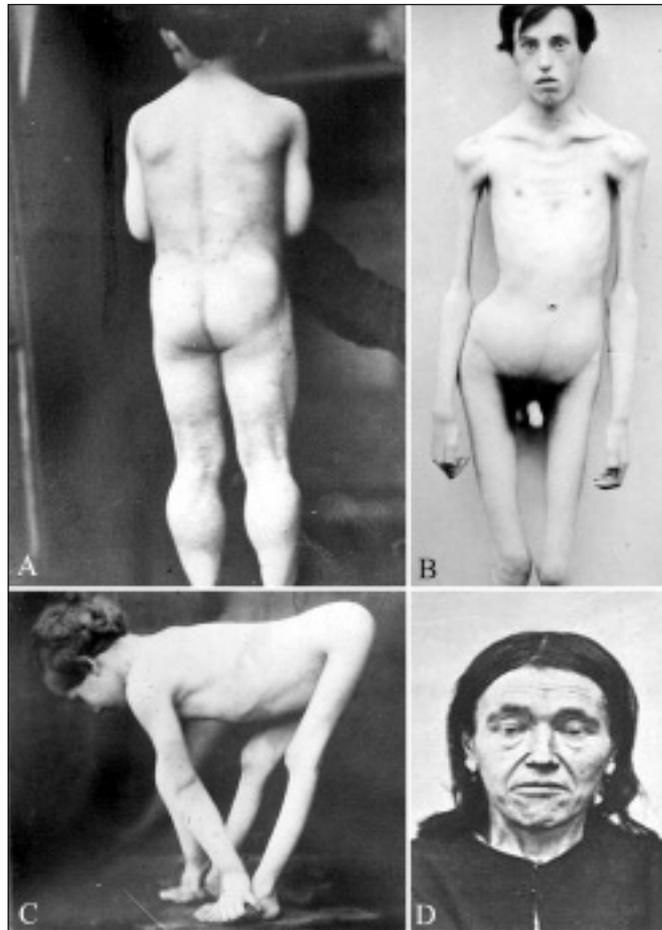


Figure 3: Duchenne on clinical pathology. A: the first representation ever of a case of pseudohypertrophic muscular dystrophy today known as Duchenne muscular dystrophy. Duchenne aptly noted the apparent hypertrophy of the paralyzed lower limbs in this young boy that contrasted with the marked wasting of the still functioning upper limb muscles. In the original figure legend, Duchenne stated: "It appears that the pathological lesion that caused the paralysis also induced the athletic development of the powerless muscles." B: a young male adolescent suffering from muscular dystrophy, probably of the fascio-scapulo-humeral type. The disease affected first facial muscles at age seven and, eight years later, progressively invaded the trunk and limbs muscles. C: a five year old boy who, according to Duchenne, was suffering from progressive muscular atrophy. The photograph illustrated the typical leg-grasping maneuver used by boys suffering from this type of disease to move around or as an attempt to stand up. D: photograph depicting the physiognomy of a woman who, according to Duchenne, was suffering from glossolabiopharyngeal (bulbar) paralysis. However, the prominent bilateral ptosis indicates that this patient was probably suffering from oculopharyngeal dystrophy. All photographs are from Duchenne (de Boulogne) GBA. *Album de photographies pathologiques*. Paris: Baillière, 1861.

avoid confusion with other Duchennes working in Paris at that time. First mocked by several senior medical staffs, his talents were finally recognized by some influential clinicians, principally Armand Trousseau (1801-1867) at the *Hotel-Dieu* hospital and Pierre-François Rayer (1793-1867) at the *Charité* hospital.¹⁻⁴ Duchenne also became acquainted with Jean-Martin Charcot (1825-1893) while the latter was an intern in Rayer's service. After he became established at *la Salpêtrière* hospital, Charcot invited Duchenne to participate in the establishment of an electrotherapy and a medical photography service at this Institution. Duchenne rapidly felt at home at *la Salpêtrière* and his presence was instrumental in Charcot's decision to embrace neurology. For Duchenne, the old hospice for women was a source of an incredible variety of human diseases that enabled him to gather exceptionally rich research material. Duchenne paid particular attention to chronic patients who were largely

neglected by the medical staff. As a result, this population of sick and hopeless peoples progressively developed a true sense of affection towards this rather strange doctor who cared for them. The following account by Brissaud is particularly revealing: "When the women at *la Salpêtrière* saw Duchenne coming along, always carrying a sort of small barrel organ, which was in fact a mahogany case with a handle that contained his famous battery and induction coil, they whispered with a sense of secrecy: *here comes the little old man with his mischief box*. But none of them had the intention of mocking Duchenne. Quite the contrary, they all requested the favor of being electrified by him."⁴

Localized faradization allowed Duchenne to depict how bodily muscles work, either in isolation or in combination with other muscles. Before Duchenne, it was generally believed that, during voluntary movements, agonist muscles contract themselves whereas antagonist muscles remain inactive.

However, Duchenne showed experimentally that any movements of the extremities or the trunk “is the result of a double nervous excitation whereby muscles that exert an opposite action (flexors and extensors) contract simultaneously, some to produce the movement and others to modulate it.”⁵ Duchenne stimulated muscles and nerves by applying two surface electrodes (*rhéophores*) to moistened skin. The electrodes were held by one hand, while the examiner operated the apparatus with the other (Figure 2A). With the help of this procedure, Duchenne was able to provide detailed functional mappings of virtually all bodily muscles, in normal individuals and in patients suffering from various types of paralysis or neuromuscular disorders. Duchenne realized that if a paralyzed muscle contracted following localized faradization then the cause of the paralysis was in the central nervous system, whereas if the muscle did not contract, it was the muscle or nerve that was damaged. In cases of nerve injuries, he also noticed that if some electrical contractibility remained in the muscle, recovery with localized faradization was usually rapid, while it was very slow when the muscle showed no contraction. However, Duchenne did not realize that muscle activity in some of these lesions probably recovered spontaneously, in spite of the treatment instead of because of it. Furthermore, he did not compare the effect of partial versus complete nerve lesions or nerve lesions versus demyelinating nerve damages. To his defense, however, it must be noted that the histological procedures that would have allowed him to differentiate direct nerve damage from demyelinating nerve damage were still in their infancy.

CLINICAL ELECTROPHYSIOLOGY AND NEUROLOGY

Duchenne described his localized faradization procedure for the first time in a memoir read at the *Académie des Sciences* in 1847.⁶ This was followed by several other papers presented at the *Académie des Sciences* and *Académie de Médecine* describing his electrophysiologic and therapeutic studies. The *Académie de Médecine* awarded him the Itard prize in 1851 for a paper on the functions of facial muscles demonstrated by localized faradization, and he became a member of the prestigious *Société de Médecine de Paris* at the same time.

Duchenne’s pioneering papers initially attracted the attention of physicists and physiologists more than that of physicians. Medical doctors considered the young Duchenne as a good self-made physicist but a poorly trained clinician, whereas physicists looked at Duchenne as a fair clinician but an amateur physicist. This is exemplified by the memorable quarrels on technical issues that occurred between Duchenne and the Becquerels (Antoine, Edmond and Alfred), a French dynasty of physicists, and between Duchenne and Robert Remark (1815-1865), a German physiologist who advocated the use of continuous electric current in the treatment of neurological diseases.² Throughout the years, however, Duchenne became a highly skilled clinician as well as a fairly good physicist.¹⁻⁴

Detailed electromyographic and clinical studies permitted Duchenne to provide accurate descriptions of various neuromuscular diseases to which his name is still attached today. In 1861, Duchenne described a young boy suffering from what he called *congenital hypertrophic paraplegia of childhood*, a condition characterized by an apparent hypertrophy of muscles, particularly those of the calves.⁵ In 1868, he provided a much

more detailed account of this disease that he then called *pseudohypertrophic muscular dystrophy* and which is known today as *Duchenne muscular dystrophy* (Figure 3A).⁷ Probably inspired by the *Middledorff’s harpoon* used in Germany to detect trichinosis in muscles,⁸ Duchenne invented a highly effective needle system (Duchenne’s harpoon), which made possible percutaneous sampling of muscular tissue without anesthesia, a forerunner of today’s biopsy (Figure 2B). Duchenne applied his biopsy technique to a young boy who suffered from pseudohypertrophic dystrophy and, following histological examination of the specimens, he noted an accumulation of fatty material in the muscles and concluded that the disease was principally localized in the interstitial muscular tissue.⁷ Although his name is associated with the disease, Duchenne was not the first to describe this still untreatable, genetic, pathological condition. Italian and German neurologists in the first half of the 19th century alluded to the disease and the London physician Edward Meryon (1807-1880) provided a thorough description of it in 1852. Meryon described this condition as a familial disorder that affected principally males. Following the autopsy of some affected individuals, he noted that the brain and spinal cord were free of pathology and reported the condition as a primary fatty degeneration of the voluntary muscles.⁹ The term *pseudohypertrophic dystrophy* was firmly established in 1879, after Duchenne’s death, by the English neurologist William Richard Gowers (1845-1915).¹⁰

Progressive spinal muscular atrophy, a variant of amyotrophic lateral sclerosis characterized by chronic progressive wasting of muscles, principally those of the upper limbs, with subsequent weakness and paralysis, is another muscular dystrophy to which Duchenne’s name is commonly associated (Figure 3B,C). However, it was François-Almícar Aran (1817-1861) who first reported the disease in 1850.¹¹ The paper obviously stemmed from a close collaboration between Aran and Duchenne; Duchenne had previously examined electrophysiologically all the patients described in Aran’s paper, and two of the 11 cases reported by Aran were based on observations made by Duchenne alone.¹² Yet, Duchenne’s name did not appear as a co-author on that paper, but Aran rightly acknowledged the role he played in a footnote. Duchenne first praised Aran’s description, but later initiated a priority quarrel that lasted long after the premature death of Aran at 44.¹² Both Duchenne and Aran believed that the primary pathology in this disease was confined to the muscles, despite the marked atrophy of the motor spinal roots reported in 1853 by Cruveilhier following the autopsy of the street acrobat Lecompte, one of the cases included in Aran’s paper.¹³ The question was finally settled in 1860 when Jules-Bernard Luys (1828-1897) who, with the help of the microscope, showed a loss of motor neurons in the anterior horn of the spinal cord in patients who had suffered from progressive muscular atrophy.¹⁴

In 1858, Duchenne described what he called *progressive locomotor ataxia*,¹⁵ a movement disorder that is symptomatic of what is known today as *tabes dorsalis* or *neurosyphilis*. This account was largely based on the notes he took during a three-month stay at Lamalou-les-Bains – a health resort located near Montpellier – at the invitation of a physician friend. The French novelist and pamphleteer Leon Daudet (1867-1942), who was doing his internship during Charcot’s time, has provided a vivid

account of Duchenne's excitement when he first saw patients passing below his window on their way to Lamalou's baths.¹⁶ Despite the early hours, Duchenne immediately ran into the apartment of his host and woke him up by shouting: "There are... Yes the people who walk there on the street, who throw their legs in walking like this – Duchenne was mimicking the typical stepping of the patients – I have recognized them. They are ataxic patients. They belong to me. I will question them all, all of them."¹⁶ Initially, Duchenne thought that locomotor ataxia was due to cerebellar lesions, but later acknowledged that syphilis might be the cause of the disease in certain cases.⁵ Duchenne gave full credit to the German neurologist Moritz Heinrich Romberg (1795-1873) for his brief but precise description of locomotor ataxia resulting from tabes dorsalis.

Duchenne also described a familial condition that was later termed *facio-scapulo-humeral muscular dystrophy* (or Landouzy-Dejerine syndrome) and recognized *glossolabiolaryngeal paralysis* (progressive bulbar paralysis) as a distinct neurological condition (Figure 3D).¹⁷ Duchenne also provided accurate clinical descriptions of syringomyelia and peripheral nerve damages, such as *facialis* and *radialis* pareses. He accurately depicted the natural course of poliomyelitis and rightly predicted that acute polio, which he called *essential paralysis of childhood*, was a motor neuron disease. He also worked on lead poisoning and designed various mechanical prostheses and orthoses to facilitate the mobility of patients suffering from various neuromuscular disorders (Figure 2D). Finally, Duchenne laid the groundwork for many of today's life-saving procedures, such as phrenic nerve stimulation (artificial respiration), electrical stimulation to relieve pain (e.g. transcutaneous electrical nerve stimulator or TENS), and the regulation of failing or fibrillating hearts by the application of regularly spaced electric shocks (cardiac pacemakers).¹⁻⁴

These various contributions were summarized in two major treatises: *De l'Électrisation localisée* (On localized faradization), which went through three consecutive editions (1855, 1861, 1872),⁵ and *Physiologie des mouvements* (Physiology of movements), which appeared in 1867 and contained some of Duchenne's finest works, including his elegant studies on the working of hand muscles.¹⁸

MEDICAL PHOTOGRAPHY

Duchenne became interested in photography early in his career, while this technique was still in its infancy. In 1862, he wrote: "From 1852 onwards, I had the idea of illustrating, with the help of this wonderful procedure [photography], the specific action of individual muscles through electrical faradization... This convinced me to learn and study the art of photography from the point of view of its application to physiology and pathology".¹⁹ Duchenne used wet collodion negatives and positive albumen prints, a procedure that required considerable technical expertise. He began to record photographically the effect of facial muscle faradization, as well as the most typical pathological cases he encountered. Results related to clinical pathology were grouped in the *Album de photographies pathologiques* published in 1862,¹⁹ as a complement to the second edition of *De l'électrisation localisée* (1861). This album is unique because it represents the first attempt to illustrate a medical book with photographs of living patients. It contains 16

albumen prints directly glued on the paper and depicting some of Duchenne's most typical patients (Figure 3).

Duchenne also used photography to describe the results of his late incursion into the field of neuroanatomy and neuropathology (Figure 4). Largely influenced by Charcot and driven by the idea that the primary pathological cause of glossolabiolaryngeal paralysis lay in the brainstem, Duchenne initiated a study of this segment of the human neuraxis. His efforts led to the production of a detailed atlas of the human brainstem that was presented to the *Académie de médecine* in 1869,²⁰ and which was intended to serve as a basis for future studies of the pathogenesis of

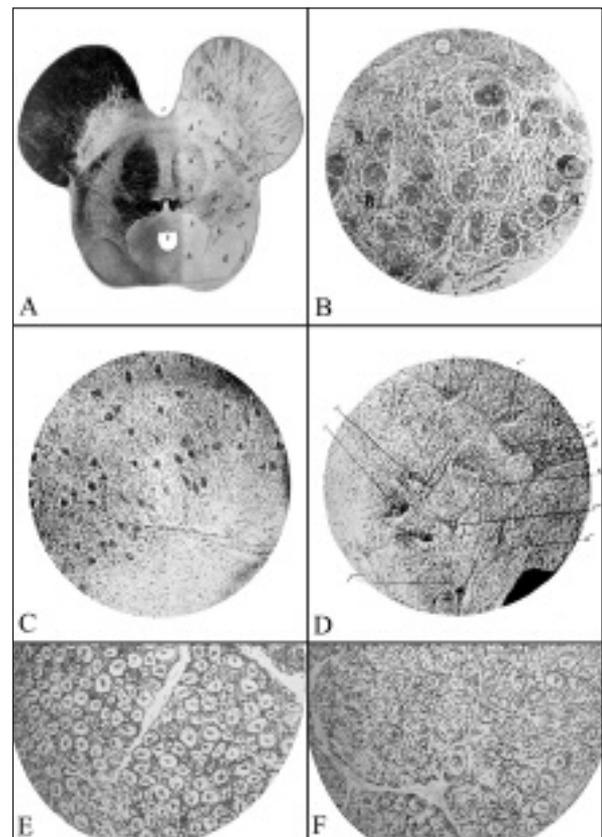


Figure 4: Duchenne on microscopic anatomy and pathology. A: a macroscopic view of human midbrain shown upside down, as it used to be the case in French neuroanatomy textbooks published in the 19th and early 20th century. B: neurons of the upper cervical ganglion taken at 190X. C,D: neurons of the inferior olive (C) and hypoglossal nucleus (D) at 150X. E,F: ventral root fibers in a normal individual (E) and in a patient with advanced locomotor ataxia (tabes dorsalis) (F) at 200X. The photographs in A, C and D are from Duchenne (de Boulogne) GBA. *Iconographie photographique. Structure intime du bulbe à l'état normal* [This atlas was presented at the *Académie de médecine* at Paris in 1869, but remained unpublished]. Figure B is from Duchenne (de Boulogne), GBA. *Anatomie microscopique du système nerveux. Recherche à l'aide de la photo-autographie sur pierre et sur zinc*. Paris: Renouard, 1865. Figures E and F are from Duchenne (de Boulogne), GBA. *Photo-autographie ou autographie sur métal et sur pierre de figures photo-microscopiques du système nerveux*. Paris: Parent, 1864.

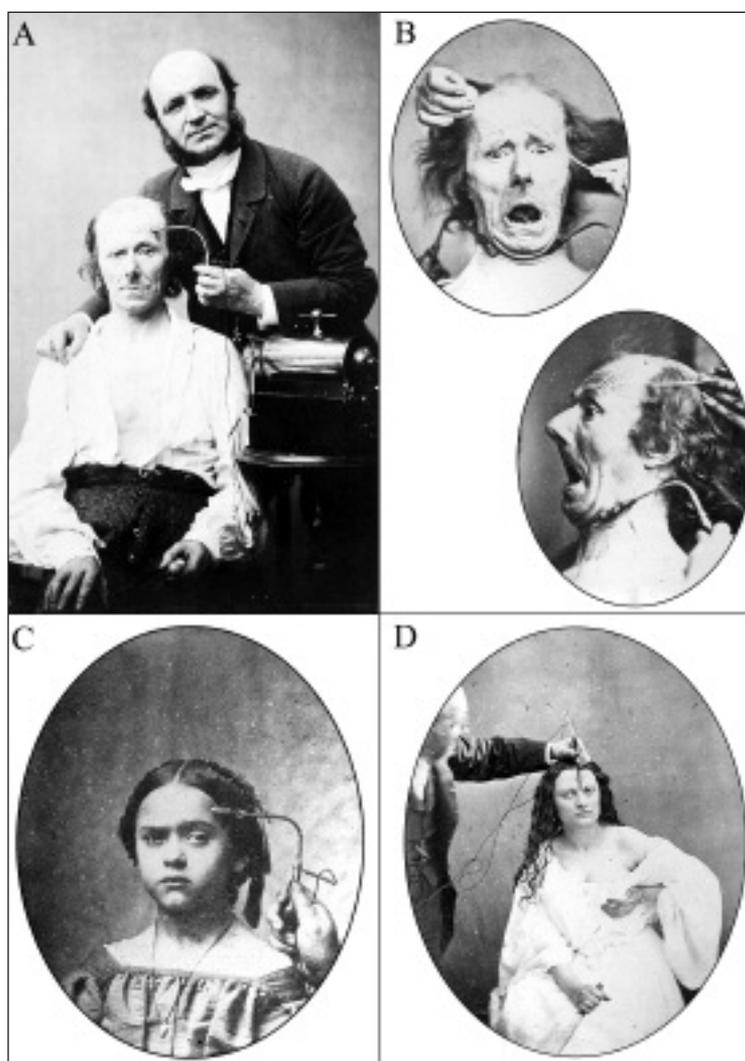


Figure 5: Duchenne on human facial expression. A: frontispiece page of Duchenne (de Boulogne) GBA. *Album de photographies pathologiques*. Paris: Baillière, 1862. This photograph illustrates Duchenne stimulating frontalis muscle of his favorite subject, the Old Man. It was probably taken by Adrien Tournachon (1825-1903), the young brother of Nadar (Felix Tournachon, 1820-1910, the photographer who became famous for his depiction of the bohemian lifestyle in the last half of the 19th century). The exact role of Adrien Tournachon in the photographic work of Duchenne is still uncertain. B: frontal and lateral views of the Old Man displaying an expression of terror and extreme pain following stimulation of different facial muscle by Duchenne. C: photograph showing the expressive lines of frontalis muscle in a young girl. Duchenne considered these fundamental lines (elevation and curvature of the eyebrow, without frontal folds), as the signs of attention. D: Duchenne reconstructing Lady Macbeth's expression of aggression with a female patient from la Salpêtrière playing the key role. The photograph, which shows Duchenne stimulating procerus muscle (muscle of aggression) in this young lady, is part of the aesthetic section of Duchenne's book on human physiognomy, a section that contains long excerpts of Shakespeare's famous play. In his naïve attempt to ensure the most exact rendition of Lady Macbeth's role, Duchenne placed a dagger in the patient's right hand and asked her to raise her left breast. The latter three photographs (B-D) are from the atlas accompanying Duchenne (de Boulogne) GBA. *Mécanisme de la physionomie humaine*. Paris: Renouard, 1862.

progressive bulbar paralysis. Duchenne's atlas of the human brainstem, which remained unpublished, contains surprisingly sharp photographs showing microscopic views of frontal, sagittal and horizontal sections of the brainstem (Figure 4A), as well as the very first photographic illustrations of brain neurons and nuclei (Figure 4C,D). Many of the macroscopic photographic views showed only one half of the brainstem sections, the other half being complemented by drawings designed to help the identification of nuclei and fiber systems (Figure 4A). These

diagrams were largely inspired from the work of the English neurologist and histologist Jacob Lockhart Clarke (1817-1880) and the German anatomist and surgeon Benedict Stilling (1810-1879), who have both contributed significantly to our knowledge of the complex anatomical organization of the human brainstem. However, Duchenne was worried about some discrepancy between his photographic depictions and Clarke and Stilling's schematic illustrations of the intimate structure of the brainstem. He had the occasion of addressing this issue with Stilling, who

visited him in 1869 to learn more about his photographic procedure applied to histology. Stilling was very much impressed by the quality of Duchenne's photographs that revealed histological details not depicted in his own atlas. Duchenne also used photography to illustrate neurons of upper cervical ganglia (Figure 4B),²¹ and the atrophy of spinal motor root fibers in advanced cases of locomotor ataxia (Figure 4E,F).²²

THE MECHANISM OF EMOTIONS

Duchenne's interest in physiological mechanisms governing human facial expression dated back to 1850, when he started to stimulate virtually all facial muscles to produce different types of expressions. The results of these investigations were summarized in his treatise *Mécanisme de la physionomie humaine* (The mechanism of human physiognomy), which went through two editions (1862, 1876).²³ The book was complemented by an atlas composed of 84 original photographs, including oval pictures that showed various forms of emotional appearances obtained in different individuals by the electric stimulation of distinct facial muscles (Figure 5). Duchenne's treatise on human physiognomy is subdivided into a scientific and an aesthetic section, and the author's ambitious aim is clearly formulated in the preface of the book: "In short, through electrophysiological analysis and with the aid of photography, I will demonstrate the art of correctly portraying the expressive lines of the human face, which I shall call the "orthography of facial expression in movement".²³

His principal photographic subject – *the Old Man* – was a cobbler hospitalized at la Salpêtrière and afflicted with an almost total facial anesthesia that enabled him to support the uncomfortable, if not painful, electrical stimulations (Figure 5A). By electrically stimulating various facial muscles, either singly or in combination, Duchenne was able to produce facial expressions that ranged from joy to stupor and extreme pain in this patient, all this being scrupulously recorded with the help of photography (Figure 5B). In answer to public criticisms about the unappealing appearance of the toothless old man, Duchenne started to use other subjects, including a sad but beautiful young girl (Figure 5C) and a seductive young woman who was nearly blind from progressive optic nerve degeneration (Figure 5D). Duchenne believed that some muscles could not easily be moved by will but only by deep emotions.²³ For example, the so-called *Duchenne's smile* refers to a difference that Duchenne believed to exist between a genuine and a false smile: "The emotion of frank joy is expressed on the face by the combined contraction of the *zygomaticus major* and the inferior part of the *orbicularis oculi*. The first muscle obeys to the will, but the second (the muscle of kindness, of love, and of agreeable impression) is only put at play by the sweet emotion of the soul. Finally, fake joy, the deceitful laugh, cannot provoke the contraction of this latter muscle."²³ Duchenne classified each facial muscle according to their degree of expressiveness: completely expressive of an emotion, incompletely expressive, expressive in a complementary way with another muscle, and inexpressive or merely static and came to the conclusion that there is a specific facial muscle for the expression of each emotion (e.g. *frontalis* for attention and *zygomaticus major* for joy).

The aesthetic section of Duchenne's book contains photographs of female patients playing different roles (e.g. Lady Macbeth), with Duchenne as art director (Figure 5D). In his

rather naïve attempts to combine science and art, Duchenne used bright light to underline astonishment and obscurity to emphasize aggression. Duchenne also assessed several classical sculptures and paintings from the point of view of his theory of human facial expression and suggested corrections for some of them, particularly the Laocoön in the Vatican Museum. According to Duchenne, the Laocoön exhibits physiologically impossible lateral forehead lines of *frontalis* muscle.

There is an obvious tint of phrenology and physiognomy in Duchenne's idea that the facial expression language was created by God and obeyed universal and immutable laws, hence giving all human beings the instinctive faculty of expressing the same feelings by contracting the same muscles.²⁴ Duchenne appears to have been well versed in physiognomy and a whiff of this pseudoscience is detectable when he wrote that the facial characteristics of the female patient he used to portray Lady Macbeth reminded him of the "features of women in history who were renowned for their cruelty."²³

Some of Duchenne's colleagues were lukewarm about this unconventional book. For example, the renowned neuro-anatomist Pierre Gratiolet (1815-1865), who was also studying human expression, questioned the very relevance of the experiments reported in Duchenne's book. He argued that they were irrelevant because the facial expression seen in Duchenne's patients were induced by artificial means, and not by internal neural processes, which he believed to be the cause of all facial and body movements.²⁵ In this regards, it is worth recalling that the classic book on medical photography published in 1893 by Albert Londe (1858-1917) contains several experiments on facial expression in hysteric and/or hypnotized patients undertaken in collaboration with the neurologist and artist Paul Richer (1849-1933), who studied hysteria under Charcot.²⁶ Londe, who started to work at the medical photography service at la Salpêtrière in 1882, stated: "It will be easy to repeat these fine experiments [those of Duchenne], but instead of using faradic current, it will suffice to excite the muscles mechanically by means of a rod or anything that has a blunt point."²⁶ These results, which were also recorded photographically, are obviously difficult to interpret, but they raise the possibility of a certain placebo effect in Duchenne's experiments. The influence of Duchenne's imposing personality on his helpless patients and the role that the patients' hope of being cured by electricity might have played in their overall behavior has remained largely overlooked.²⁷

Duchenne's book nevertheless influenced the famous evolutionist Charles Darwin (1809-1882), who held Duchenne in high esteem and was sorry that his work was considered lightly, if not completely neglected, by some of his compatriots. Darwin even borrowed a number of Duchenne's photographs to illustrate his own book on *The expression of the emotions in man and animals*, published in London in 1872.²⁸ Duchenne may have failed in his attempts to use the results of his experiments on facial expression to "formulate rules to guide the artist in the true and complete portrayal of the soul," but the intrinsic value of his observations are being rediscovered by contemporary artists and scientists. For example, the curators of the *École Nationale Supérieure des Beaux-Arts* in Paris has recently organized a highly successful exposition centered upon Duchenne's photographic album, which they considered a true incunabulum

of photography.²⁹ Furthermore, Duchenne's knowledge of facial muscle activity in emotional expression has served as a basis for scientific investigations as varied as cross-cultural research on facial expression in normal individuals and in psychiatric and brain-lesioned patients, facial plastic surgery and computerized facial expression recognition.³⁰⁻³⁴

THE LAST YEARS

Duchenne's reputation was already well established when his book on human facial expression appeared in print. A member of several learned societies worldwide, he was made *Chevalier de la Légion d'Honneur* by Napoléon III (1808-1873) in 1858. Furthermore, the private life of Duchenne completely changed when the son he had hardly known returned to him in 1862. At the death of his maternal grandmother in 1851, Guillaume-Maxime moved from Boulogne to Strasbourg, where he became an army physician. After having served as *médecin-major* during many years in North Africa and Turkey, he decided to settle down in Paris and follow the path of his father by practicing neurology. In 1864, he successfully defended a thesis on atrophic paralysis of childhood that he dedicated to his father. Unfortunately, the French-Prussian war of 1870-1871 put an end to this happy period. Anticipating the siege of Paris by the Prussian army, Duchenne's wife Honorine fled to England, while he stayed to take care of the wounded Parisians. His wife died in December 1870 and, less than a month later his beloved son Guillaume-Maxime was taken away from him by typhoid fever.² Duchenne attempted to get away from this ordeal by traveling. He visited Austria, England and Spain, where he was received and celebrated by the highest authorities. The socially awkward Duchenne even began to invite, on a regular basis, several medical authorities for dinner at his home.

Duchenne, whose health was seriously declining, benefited from the help of his daughter-in-law Julie Bonnel in the preparation of the final revision of *De l'électrisation localisée*. In August 1875, Duchenne suffered a stroke from which he never really recovered. He remained lucid until the last moment and recorded with his still able hand the evolution of the hemiparesis that was affecting him.² Duchenne died on September 17, 1875 at age 69 and his funeral took place four days later in his native town. Significantly, Duchenne bequeathed the complete series of his original large-format photographs that served to illustrate his book on human physiognomy not to the *Faculté de médecine* but to the *École Nationale Supérieure des Beaux-Arts* of Paris, where this unique collection can still be admired.³⁵ Some of these prints have retained the movable mask, which allows the different expressions on each half of the face to be clearly read.

Duchenne received honors from several foreign institutes, universities, and academies, but himself neither belonged to the French academy of sciences or a French University. After his death, he was honored with a simple bas-relief (Figure 6A) that was placed on the wall of la Salpêtrière's infirmary. It was officially unveiled on June 17, 1897. The bas-relief was lost for many years after the infirmary was demolished during the first half of the 20th century, but the central part of it – the so-called medallion – was rediscovered recently. It now proudly stands at the amphitheater's entry of the Myology Institute located in the Babinski building at the Pitié-Salpêtrière hospital complex (Figure 6B).

Duchenne's personal file at the *Académie Nationale de médecine*



Figure 6: Duchenne's bas-relief at la Salpêtrière. A: a photograph of the original monument that used to hang on the wall of the infirmary at la Salpêtrière before the Second World War. It was commissioned to the sculptor Charles Desvergnès (1860-1928) and paid for through a long and difficult fund raising effort led by Charcot and colleagues. The figure is from Guilly, P.J.L. Duchenne de Boulogne. MD thesis. Paris: Baillière, 1936. B: a photograph showing the bas-relief's central panel, which was recently rediscovered and now stands at the amphitheater's entry of the Myology Institute at the Pitié-Salpêtrière hospital complex. It shows Duchenne stimulating the forearm muscles of a patient lying in his hospital bed. There was originally an inscription below the medallion that read as follows: "À Duchenne de Boulogne. Électrisation localisée, Physiologie des mouvements, Neuropathologie. Charles Desvergnès" This photograph was taken by the author.

in Paris contains, among several documents of interest, a 12-page long eulogy that was most likely written by a member of the Academy, but whose name does not appear on the document.³⁶ The text begins as follows: "It is a pious custom for the ancient members of our Company to receive a public eulogy. But, for various reasons, and as it is the case in all human judgments, the Academy sometime makes mistakes in the choice of its members, or forget or neglect some names that have honored it." The rest of the text provides a fair description of the personal life and scientific contributions of Duchenne.

Unfortunately, at the bottom of the first page of this eulogy,

one finds the following hand-written note: "This eulogy was to be pronounced at the annual public session of the Academy of Medicine scheduled for December 1939. The events of the war decided otherwise."

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REFERENCES

- Lasègue CE, Strauss I. Duchenne (de Boulogne). Sa vie scientifique et son oeuvre. Paris: Asselin, 1875; 1,3-5.
- Guilly PJL. Duchenne de Boulogne. MD thesis. Paris: Baillière, 1936; 2,4,8.
- Cuthbertson RA. Duchenne de Boulogne. His life, his time and the significance of his work with special reference to his study of the mechanism of human expression. MD thesis, University of Melbourne, 1977; 4-5. [in the form of 1-4].
- Brissaud E. L'oeuvre scientifique de Duchenne de Boulogne. [Text of the speech pronounced by Brissaud at the Boulogne Congress on September 21, 1899]. Archives d'électricité médicale 1899; 449-468; 2-5.
- Duchenne (de Boulogne) GBA. De l'électrisation localisée et de son application à la physiologie, à la pathologie et à la thérapeutique. Paris: Baillière, 1855. [2nd edition, 1861; 3rd edition, 1872; English translation and edition by Poore GV. Selections from the clinical works of Duchenne (de Boulogne). London: The New Sydenham Society, 1883]; 4-5.
- Duchenne (de Boulogne) GBA. De l'art de limiter l'excitation électrique dans les organes sans piquer ni inciser la peau, nouvelle méthode d'électrisation appelées électrisation localisée. Paris: Académie des Sciences, 1847; 4.
- Duchenne (de Boulogne) GBA. De la paralysie musculaire pseudo-hypertrophique ou paralysie myo-sclérotique. Arch Gén Méd 1868; 11: 5-25, 179-209, 305-321, 421-443, 552-588.
- Nelson KR, Genain C. Duchenne de Boulogne and the Muscle Biopsy. J Child Neurol 1989; 4: 315.
- Meryon E. On granular or fatty degeneration of the voluntary muscles. Med-Chir Trans 1852; 35: 73-85.
- Gowers, WR. Pseudo-hypertrophic muscular paralysis. Lancet 1879; 2: 737-750.
- Aran FA. Recherches sur une maladie non encore décrite du système musculaire (atrophie musculaire progressive). Arch Gén Méd (Paris) 1850; 24: 4-35, 172-214.
- Bonduelle M. Aran-Duchenne ? Duchenne-Aran ? La querelle de l'atrophie musculaire progressive. Rev Neurol (Paris) 1990; 146: 97-106.
- Cruveilhier LJB. Sur la paralysie musculaire, progressive, atrophique. Bulletin de l'Académie de Médecine (Paris) 1853; 18: 490-502, 546-584.
- Luis JB. 1860. Atrophie musculaire progressive. Lésions histologiques de la substance grise de la moëlle épinière. Gazette médicale de Paris, 3e série 1860; 15: 505.
- Duchenne (de Boulogne) GBA. De l'ataxie locomotrice progressive. Arch Gén Méd (Paris) 1858; 12: 641-652, 13: 36-62, 158-181, 417-451.
- Daudet L. Souvenirs des milieux littéraires, politiques, artistiques et médicaux de 1880 à 1905; devant la douleur. Paris: Nouvelle librairie nationale, 1915; 5.
- Duchenne (de Boulogne), GBA. Paralysie musculaire de la langue, du voile du palais et des lèvres; affection non encore décrite comme entité morbide distincte. Arch Gén Méd 1860; 16: 283-296, 431-445.
- Duchenne (de Boulogne) GBA. Physiologie des mouvements démontrée à l'aide de l'expérimentation électrique et de l'observation clinique, et applicable à l'étude des paralysies et des déformations. Paris, Baillière, 1867; 5.
- Duchenne (de Boulogne) GBA. Album de photographies pathologiques complémentaire du livre intitulé de l'électrisation localisée. Paris: Baillière, 1862; 5.
- Duchenne (de Boulogne), GBA. Iconographie photographique. Structure intime du Système Nerveux de l'homme à l'état Normal et à l'état Pathologique. Structure intime du bulbe à l'état normal. Premier fascicule présenté à la Société de Médecine de la Seine le 16 octobre 1868 et à l'Académie de médecine de Paris en 1869; 5.
- Duchenne (de Boulogne) GBA. Anatomie microscopique du système nerveux. Recherche à l'aide de la photo-autographie sur pierre et sur zinc. Paris: Renouard, 1865; 7.
- Duchenne (de Boulogne) GBA. Photo-autographie ou autographie sur métal et sur pierre de figures photo-microscopiques du système nerveux. Paris: Parent, 1864; 7.
- Duchenne (de Boulogne) GBA. Mécanisme de la physionomie humaine, ou analyse électro-physiologique de l'expression des passions, applicable à la pratique des arts Plastiques. One volume and a photographic atlas. Paris: Renouard, 1862. [2nd edition, Paris: Baillière, 1876; English translation by Cuthbertson RA. The mechanism of human facial expression, New York: Cambridge University Press, 1990]; 7.
- Cuthbertson, RA. The highly original Dr. Duchenne. In: Cuthbertson RA, The mechanism of human facial expression, 225-241, New York: Cambridge University Press; 1990; 7.
- Gratiolet, P. De la physionomie et des mouvements d'expression. Paris: Hetzel, 1863; 7.
- Londe A. La photographie médicale. Application aux sciences médicales et physiologiques. Paris: Gauthier-Villars, 1893; 7.
- Goldblatt D. Amo Amand/Amant. Semin Neurol 1990; 10: 210-216.
- Darwin C. The expression of the emotions in man and animals. New York: Greenwood Press, 1872; 7.
- Mathon, C. Duchenne de Boulogne (1806-1875) [Exposition's catalogue]. Paris, École Nationale Supérieure des Beaux-Arts. 1999; 8.
- Hueston JT, Cuthbertson RA. Duchenne de Boulogne and facial expression. Ann of Plast Surg 1978; 1: 411-420.
- Ekman P, Davidson RJ, Friesen WV. The Duchenne smile: Emotional expression and brain physiology. II. Pers Soc Psychol 1990; 58: 342-353.
- Adolph R. Neural mechanisms for recognizing emotion. Curr Opin Neurobiol 2002; 12: 169-178.
- Ekman P. Emotions Revealed: Recognizing Faces and Feelings to Improve Communication and Emotional Life. New York: Henry Holt, 2003; 8. [in the form of 1-4].
- Vuilleumier P. Cognitive science : staring fear in the face. Nature 2005 ; 433 : 22-23.
- Debord JF. The Duchenne de Boulogne collection in the Department of morphology, l'École Nationale Supérieure des Beaux-Arts. In: Cuthbertson RA (Ed). The mechanisms of human facial expression, 242-256, New York: Cambridge University Press; 1990.
- Anonymous. Guillaume Duchenne de Boulogne. 1806-1875. [Unpublished eulogy to Duchenne de Boulogne]. Paris: Académie Nationale de Médecine, 1939.