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From Aldini's galvanization of human bodies to the Modern Prometheus

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Abstract. During the 18th century the perception of electricity was significantly different from it is today. In particular, the idea of 'bioelectricity' - the electrical phenomena that control our body - was trying to surface among a set of multifaceted studies and innovative processes involving electricity. The concept of animal electricity finally emerged at the very end of the 18th century thanks to the work of the Italian physician, physicist and anatomist at the University of Bologna, Luigi Galvani, whose findings were disputed by the physicist Alessandro Volta, from Como. At the beginning of the 19th century, Giovanni Aldini, the nephew of Galvani, attempted to demonstrate the existence of animal electricity by using voltaic batteries to stimulate the corpse of animals and humans, often in front of laypersons. One of these public events occurred in London on January 17, 1803, when Aldini applied electrical stimulation (at that time called Galvanic stimulation) on the corpse of a hanged criminal, 'almost to give an appearance of re-animation'. The results of such gruesome exhibitions were reported in detail by local newspapers, ingraining the idea that electricity might be the long-sought vital force. The English writer Mary Shelley is likely to have been influenced by such events, which suggest the possibility of reanimating dead bodies by the application of electricity. She ingeniously put this concept into action in her highly influential gothic novel Frankenstein, or the modern Prometheus that was first published exactly 200 years ago.

Key words: Giovanni Aldini, galvanism, Mary Shelley, Frankenstein, electricity

«Tema della *pièce*?»
«La vita e la morte».
«Impegnativo. Attore unico?»
«No, due. Ma il secondo non parla».
«Allora che ci sta a fare in scena?»
«Si suppone debba muoversi».
«Si suppone?»
«Non è detto che accada»
(*Manfredi G. Tecniche di resurrezione. 2010 Gargoyle Books, Roma. p.14*)

«Subject of the play?»
«Life and death».
«Challenging. Only one actor?»
«No, two. But the second doesn't talk».
«But then, what is he doing on the scene?»
«He is supposed to move».
«Supposed?»
«There's no guarantee it happens»

Introduction

The medical use of electricity dates back to Antiquity, as revealed by the Roman physician Scribonius Largus, whose writing published in the first century, mentioned the use of electric shocks of black torpedoes to treat pathological conditions as varied as headache and gout (1). However, it was not before the 18th century that the concept of electricity became clearer and its use as a medical tool made more appropriate. The first steps along this path are the electrical conduction experiments of the English scientist Stephen Grey (1666-1736) and the invention of the Leyden Jar, attributed to the Dutch physicist Pieter van Musschenbroek (1692-1761). Later on came the discovery of 'animal electricity' by Luigi Galvani (1737-1798) - he acknowledged Pierre Bertholon (1741-1800) as the inventor of the term *animalis electricitas* in his 1791 *Commentarius* (2) - and the development of the first electrical battery by Alessandro Volta (1745-1827) (3, 4, 5). The growing enthusiasm associated with the use of electricity, even for pleasure (as in Gray's experience or alcohol lighting), led the Venetian physician Eusebio Sguario to explicitly declare (Dissertazione II, p. 366-7):

> '*Ciò che ricercano gli uomini dalle scienze non essendo solamente il dilettevole, quanto l'utile […]: appena si conobbe, che tanto era il potere che aveva l'elettricità sui corpi umani, che subito si ricerco s'ella avrebbe potuto mai per buona ventura apportar qualche sollievo ai mancamenti della salute. Nessun pensiero era più facile a cader in mente di questo…*' (*What people look for in science is not only pleasure, but usefulness […]: as soon as the power of electricity on human bodies was known, research was initiated to see if it could be used to bring relief to the failures of health. No thought was easier to conceive than that one…*) (6).

At that time, electricity started to be used more or less successfully as a remedy for pathologies that ranged from paralysis to blindness, and from rheumatisms to hysteria (3,4). However, the interest in this 'new' field continuously increased and, during the second half of the 18^{th} century, electricity was often defined as something 'marvelous', as for example, '*the wonderful effect of pointed bodies*' (Franklin, 1747) (7), '*les merveilleux effets qu'on attribuait depuis quelques années à l'électricité*' (Nollet, 1749) (8), or '*il fenomeno fu costante ed è certo meraviglioso*', referring to frog's movement after stimulation (L. Galvani, 1781) (4).

The exponential growth of such studies and experiments created an indissoluble link between electricity and medicine. Questions so far related to theology and philosophy, such as the nature of life itself started to be considered by physicians, scientists and writers (9). This novel attitude contributed to pave the way to the birth of Romantic medicine and yielded some concepts that were integrated into the first true work of science fiction, *Frankenstein; or, the Modern Prometheus* (1818), by Mary Shelley (10).

Galvani-Volta controversy

Luigi Galvani (Fig. 1, left), son of Domenico and Barbara Foschi, was born in Bologna, Italy, on September 9, 1737. Although he had shown a strong inclination for religious life since he was a child, Galvani entered the Faculty of Arts of the University of Bologna, where he attended the medicine course during the second half of the 1750s. One of his professors was Jacopo Bartolomeo Beccari (1682–1766), *anatomicus emeritus*, who taught Galvani the basic notions of medicine and chemistry. Galvani also followed the lectures in physic given by Domenico Gusmano Galeazzi (1686 –1775), who ran one of the most modern laboratories in Italy and taught contemporary disciplines such as electricity, a hot topic of that time that attracted Galvani's interest.

While studying electricity, the young Galvani progressively became a skilled surgeon and applied his ability to treat patients as well as to perform animal experiments (2). In 1759 he graduated in both medicine and philosophy - it was a usual custom at the University of Bologna - and then worked for 3 years as a permanent anatomist (*anatomici ordinari*) of the University. In 1762 Galvani married Galeazzi's daughter Lucia (1743-1788), moving to Galeazzi's house, where he probably took the inspiration for his own researches (2). Strongly interested in the therapeutic use of elec-

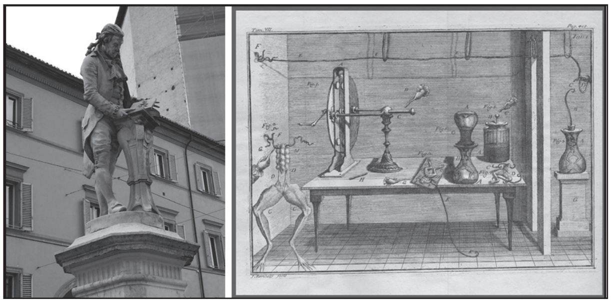

Figure 1. The statute of Luigi Galvani in Piazza Galvani in front of the *Archiginnasio*, in Bologna (left) and a copy of the first plate of his *Commentarius* published in 1791 (11, right). Credit: Wellcome Collection.

tricity, he began a series of experiments on muscle contraction in frogs. He reported the results of enlightening investigation in a famous work entitled *De Viribus Electricitatis in Motu Musculari. Commentarius* (Commentary on the Effect of Electricity on Muscular Motion) published in 1791 by the Academy of Sciences of Bologna (11). Of note is the experiment he did on January 26, 1781, in which a dissected frog '*alla maniera di Galvani*' was left on the table close to an electrical machine but not physically connected with it. When an assistant - probably his wife or his nephew Aldini, who often helped him in the laboratory - touched the femoral nerve with a scalpel, a strong muscular contraction ensued, in conjunction with a spark discharge from the prime conductor (Fig. 1, right). This crucial experiment, which appears first in the *Commentarius*, gave Galvani the idea of an intrinsic form of electricity within the muscle, which, when activated by the electrical flow through the nerves, leads to muscle contraction (12). Galvani also expressed the idea that the animal electricity (or the nerveo-electric fluid; he used both terms) was not different from artificial electricity. He saw it as being generated in the brain, distributed through the inner core of nerves covered by an outer oily layer that prevents electrical diffusion, as far down as to the muscles (3, 13). These ideas, which ruled out the old Galenic concept of animal spirit flowing through hollow nerves, were considered revolutionary, although judged with caution (4, 5, 14).

A scientist from Como, Alessandro Volta, at that time professor of 'experimental physics' at the University of Pavia, was among the first to reproduce Galvani's experiments and to embrace the concept of animal electricity. In his *Memoria prima sull'elettricità animale* (First Memoir on Animal Electricity) dated May 5, 1792, he refers to '*una di quelle grandi e luminose scoperte, che meritano di far epoca negli annali delle scienze fisiche e mediche*' (one of those great and luminous discoveries which deserve to be a landmark in the annals of physical and medical sciences) (15).

Alessandro Giuseppe Antonio Anastasio Volta (Fig. 2, left), son of Count Filippo and Countess Maddalena Inzaghi, was born in Como on February 18, 1745. He went to the Jesuit School in Como and, while pressed toward legal studies, the young Volta expressed preferences for physics, an orientation that was supported by the family friend Canon Giulio Cesare Gattoni who was teaching at the Royal Benzi Seminary. At 24, Volta writes his first treatise on electric phenomena *De vi attractiva ignis electrici ac phaenomenis independentibus* (On the forces of attraction of electric fire), a merely hypothetical work. In 1774 he accepted a professorship at the Royal School in Como and, in 1779, he moved to Pavia (16). Volta was 45 old and already an authority in the field of electricity when he first read Galvani's *Commentarius*; he had already invented the '*electrophorus*' a generator of electricity and the '*condensatore*', an instrument able to detect small quantities of electricity (12).

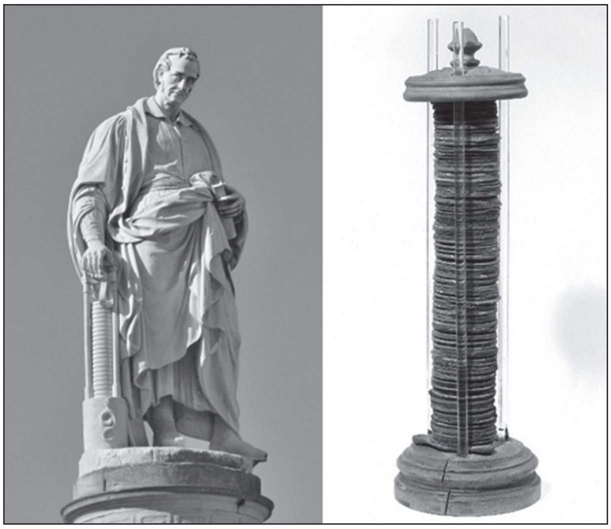

Figure 2. The statute of Alessandro Volta in Piazza Volta, in Como (left) and a photograph of his bi-metallic (voltaic) pile (right). Credit: Como City-hall and Wellcome Collection.

Volta's initial enthusiasm over Galvani's findings progressively changed into skepticism. In his *Memoria prima sull'elettricità aniamle*, in 1792, he wrote: '*una giacchè o due di tali sperienze [...] sembran pure indicare qualche cosa di vera elettricità animale, sebben non provi neppure questa decisamente*' (One or two features [...] suggest something real about animal electricity, although they do not prove it decisively) (15). Volta then argued that the muscular contractions observed by Galvani were in fact generated by the two different metals used to connect nerves and muscles, and not by intrinsic animal electricity. He thought that there was no need of any biological preparation to produce electricity since two different metals were sufficient to do the work. What was initially a simple scientific controversy soon became a legendary dispute between Volta and Galvani that attracted worldwide attention (5, 12). During the last years of the 18^{th} century, the German physiologist Emil Du Bois Reymond (1818-1896) gave a clear summary of the various aspects of Galvani's and Volta's theories in his voluminous treatise *Untersuchungen über thierische Elektricität* (Investigation of Animal Electricity) (17):

> '*It can be said that wherever it was possible to find frogs and heterogeneous pieces of metal they were immediately put in contact, and anybody could be convinced, through evidence, of the wonderful resuscitation of severed limbs. Physiologist believed that they could hold in their hands the ancient dream of the life force; physicians […] believed that any treatment would be possible, and that any apparent dead body would have not been buried before being galvanized*' (4).

Volta later used the idea of '*elettricità metallica*' (metallic electricity) to create his famous electric pile (Fig. 2, right) that he first called '*organe électrique artificiel*' (artificial electric organ) to distinguish it from to the '*organe électrique naturel*' (natural electric organ) of the torpedo, whose structural organization seems to have inspired, at least in part, his own invention (3, 5). He presented his great discovery on March 20, 1800 in a letter addressed to the Royal Society of London and, in 1801 he demonstrated his battery to the French Emperor Napoléon Bonaparte, who made him a count and a senator of the kingdom of Lombardy.

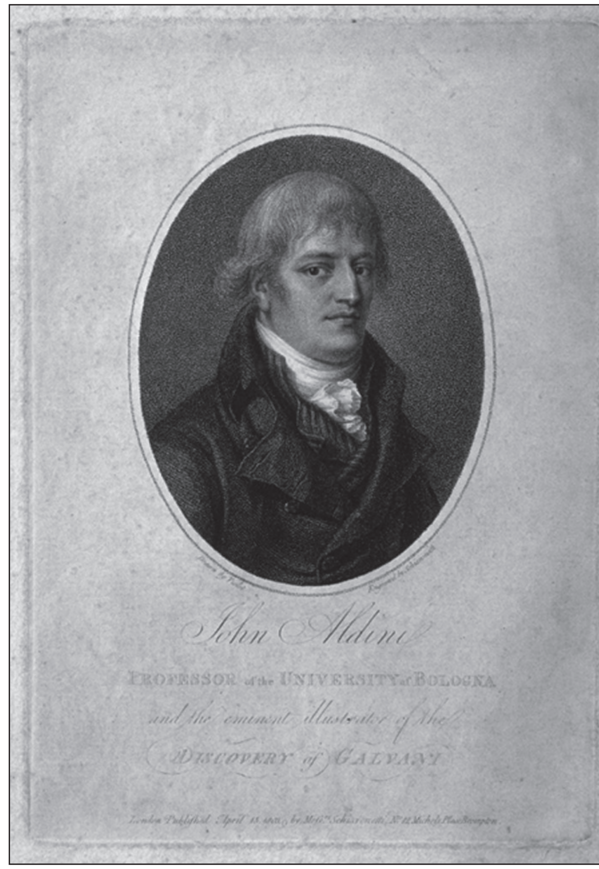

Figure 3. A portrait of Giovanni Aldini as it appears on his 1803 Account of the late improvements in Galvanism (25). Credit: Wellcome Collection.

Aldini steps forward

In contrast to Volta, Galvani had a reserved character and he progressively led his more communicative nephew Giovanni Aldini in charge of the defense of the animal electricity concept (2). Giovanni Aldini (Fig. 3), son of Giuseppe and Caterina Galvani, was born in Bologna on April 16, 1762. His father was a law professor and his mother, the sister of Luigi Galvani, had a great influence on the orientation of Giovanni toward science. After graduating in physics, he started working with his uncle and developed a great passion for electricity and Galvanism, a term introduced during the last years of the 18^{th} century (5, 13).

Aldini became a great defender of his uncle theories and Galvanism. He prepared a second edition of the *Commentarius* that appeared in Modena in the autumn of 1792, with new experiments using only one metal to produce muscle contraction. In 1794 he helped Galvani in publishing, although anonymously, the *Trattato dell'Arco Conduttore* (Treatise on the Conducting Arc), with still new experiments in which muscle contraction was obtained without any metal (18), a sort of response to Volta's criticism (13). In 1794 Aldini published his own *De animali electricitate dissertationes duae* (Two dissertations on animal electricity) (19), a treatise describing the results he obtained on animal electricity, including experiments undertaken on warm-blooded animals. Furthermore, Aldini significantly contributed to Galvani's last work *Memorie sulla elettricità animale* (Memoir on animal electricity), published in 1797 in the form of a letter to Lazzaro Spallanzani (1729-1799), a firm believer of his theory (5, 13). Galvani died in 1798, the year when Aldini took the Bologna University chair in physics, vacant after the retirement of his former master Sebastiano Canterzani (1734-1819). Despite Galvani's death and his new teaching commitments, Aldini carried on his work on Galvanism founding, in the late 1790s, the Galvanic Society. While Galvani's researches had been conducted almost entirely on frogs, Aldini explored more esoteric paths, involving experiments on the heads of different warm-blooded animals, particularly oxen and lambs (Fig. 4).

While performing these animal studies, Aldini found that the stimulation of one hemisphere produces muscle contractions on the opposite side, an important finding that was to be better described in the late 19th century by Fritsch and Hitzig in dogs and by Robert Bartholow in humans (20). In addition, he noted that stimulations of different brain regions produce specific effects, leading him to appreciate the use of electrical stimulation as a therapeutic tool in humans (21). Ironically, Aldini had to use Volta's bimetallic battery to convince scientists and physicians of the therapeutic usefulness of Galvanism. He initially tested Galvanic stimulation upon himself, reporting:

> '*D'abord le fluide s'empara d'une grande partie du cerveau, qui éprouva une forte secousse, et comme une espèce d'ébranlement contre la parois de la boîte osseuse. Les effets augmentèrent encore, lorsque je conduisis les arcs d'une oreille à l'autre. J'ai ressenti une forte action à la tête, et une insomnie prolongée pendant plusieurs jours…*' (*First, the fluid took over a large part of my brain, which felt a strong shock, a sort of jolt against the inner surface of my skull. The effect increased further as I moved the electric arcs from one ear to the other. I felt a strong head stroke and I became insomniac for several days…*) (22).

Later, Aldini applied Galvanic stimulation to the head of Luigi Lanzarini, a 27-year-old farmer suffering from melancholy (major depression), who had been committed to Sant'Orsola Hospital, in Bologna, on May 17, 1801, thus pioneering the idea of modern transcranial electrical stimulation developed in the 20th century (23, 24) (Fig. 5). After 6 weeks of such treatment, Aldini reported that the patient's mood had progressively improved up to the point that Lanzarini was considered "*complètement guéri*" (completely cured) (22).

In January and February 1802, Aldinin applied Galvanic stimulation on the bodies of three criminals executed by decapitation close to the Bologna's Palace of Justice (Fig. 6). Marked muscular contractions of various types resulted from the application of electric arcs on different parts of these corpses, and Aldini noted that such effects were still elicitable up to three hours

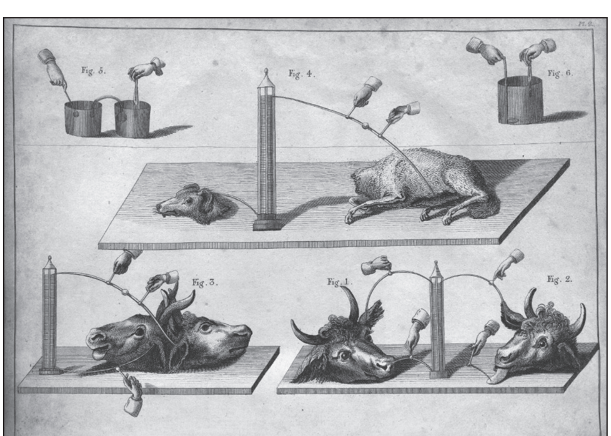

Figure 4. A copy of plate II in Aldini's 1803 *An account of the late improvements in Galvanism* (25). Courtesy of the Center for the History of Medicine of the Harvard University.

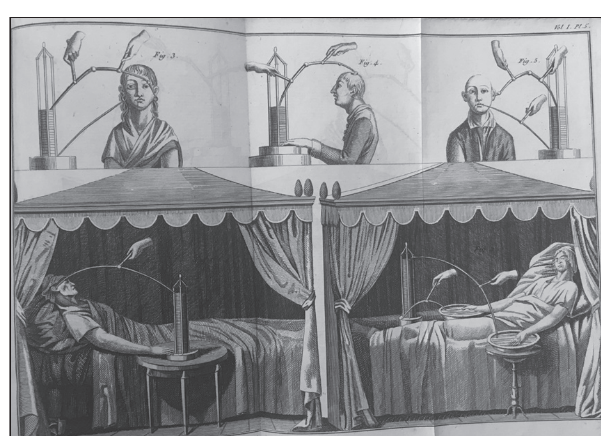

Figure 5. A copy of plate V in Aldini's 1804 *Essai théorique et experimental sur le Galvanisme,* volume I (22). Courtesy of the library of the Department of Physics of the University of Turin.

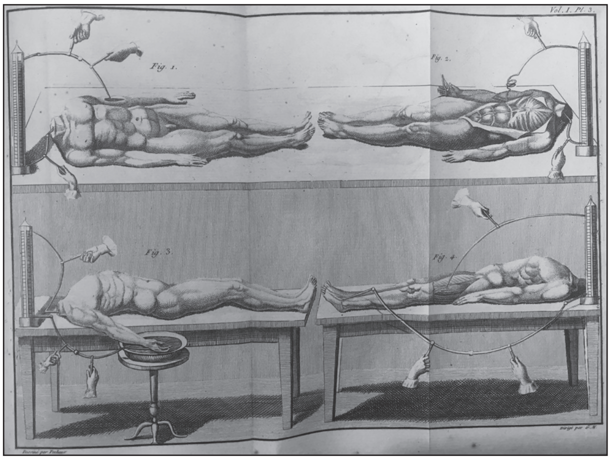

Figure 6. A copy of plate 3 in Aldini's 1804 *Essai théorique et experimental sur le Galvanisme,* volume I (22). Courtesy of the library of the Department of Physics of the University of Turin.

after death. These results appeared in Aldini's 1804 treatise (2-volume, 680-page) entitled '*Essai théorique et expérimental sur le galvanisme*', together with the surprising observation that the heart – considered the most important of all the muscles – was unresponsive to Galvanic stimulation (22).

Aldini's European tour

To persuade the scientific community of the existence of animal electricity and the importance of Galvanism in medicine Aldini initiated a European tour. In the fall of 1802 he was at the Salpêtrière Hospital in Paris attempting to convince the famous psychiatrist Philippe Pinel (1745-1826) of the beneficial effects of Galvanic stimulation on depressed patients. Aldini applied the same therapy he used in Bologna, but with a limited success (20, 22). At the beginning of 1803, Aldini went to England, where he was invited to present his data on Galvanism and to give practical lessons in Oxford and London. At the College of Surgeons, in London, on Monday, January 17, Aldini undertook his most famous demonstration on the body of a malefactor executed by hanging (Fig. 7) at the Newgate Prison (25). It is worth noting that the Newgate Calendar reported that Foster's execution took place on January 18, and not on the 17th, as reported by Aldini (13). Referring to the *The Murder Act* of 1751 (26), Aldini stated:

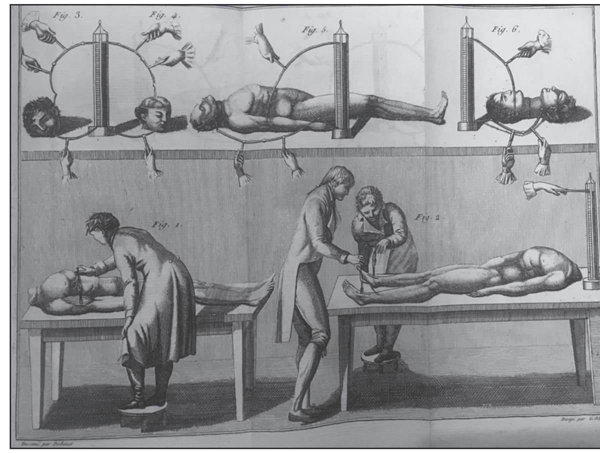

Figure 7. A copy of plate IV in Aldini's 1804 *Essai théorique et experimental sur le Galvanisme,* volume I (22). Courtesy of the library of the Department of Physics of the University of Turin.

> '*the British laws, which are founded on the basis of humanity and public benefit, that the bodies of those who during life violated one of the most sacred rights of mankind, should after execution be devoted to a purpose which might make some atonement for their crime, by rendering their remains beneficial to that society which they offended*' (25; Appendix pp. 189-190).

London offered Aldini his first possibility to apply Galvanism on an intact human body, and not on decapitated corpses, as he had previously done in Bologna. One of his ideas behind such demonstrations was to convince the scientific community that Galvanism could be used in cases of '*asphyxia and suspended animation*' associated with drowning (25), a concept that Aldini expounded in his work *An account of the late improvements in Galvanism* (Fig. 8):

> '*In a commercial and maritime country like Britain, where so many persons, in consequence of their occupations at sea, on canals, rivers, and in mines, are exposed to drowning, suffocation, and other accidents, this object is of the utmost importance in a public view, and is entitled to every encouragement*' (25).

Aldini was convinced that the '*power*' that occurs in muscular fibers and disappears after death could be

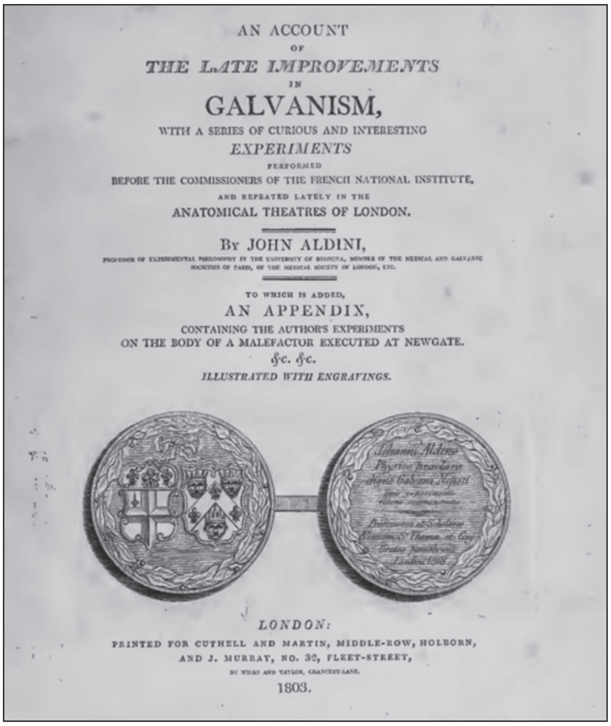
AN ACCOUNT
OF
THE LATE IMPROVEMENTS
IN
GALVANISM,
WITH A SERIES OF CURIOUS AND INTERESTING
EXPERIMENTS
PERFORMED
BEFORE THE COMMISSIONERS OF THE FRENCH NATIONAL INSTITUTE,
AND REPEATED LATELY IN THE
ANATOMICAL THEATRES OF LONDON.
By JOHN ALDINI,
TO WHICH IS ADDED,
AN APPENDIX,
CONTAINING THE AUTHOR'S EXPERIMENTS
ON THE BODY OF A MALEFACTOR EXECUTED AT NEWGATE.
&c. &c.
ILLUSTRATED WITH ENGRAVINGS.
LONDON:
PRINTED FOR CUTHELL AND MARTIN, MIDDLE-ROW, HOLBORN,
AND J. MURRAY, NO. 32, FLEET-STREET,
1803.

Figure 8. Title page of Aldini's 1803 *Account of the late Improvement of Galvanism* (25).

regained through Galvanism. The criminal, George Foster, was a 26-years-old man who '*seemed to have been of a strong, vigorous constitution*'. Foster had been sentenced for the murder of his wife and child, who were drown in the Paddington Canal (13, 27). Under the supervision of Mr. Keate, master of the Society, Mr. Carpue, lecturer on anatomy and his pupil Mr. Hutchins, '*gentlemen eminently well skilled in the art of dissection*', Aldini '*readily embraced that opportunity of subjecting it to the Galvanic stimulus, which had never before been tried on a person put to death in a similar manner*'. During his demonstration, Aldini received the help of Mr, Cuthbertson, who directed and arranged the Galvanic apparatus (25, 27). In the appendix Aldini reports in detail all the [15] experiments he performed on the executed body of Foster, and all the conclusions he was able to deduce from them (25).

In the first two experiments, the current generated from '*three troughs combined together, each of which contained forty plates of zinc, and as many of copper*' a typical '*Volta's pile*', was applied to the mouth, to both ears or to one ear and the nostrils. Those stimulations generated jaw tremor, eyes opening and '*a convulsive action of all the muscles of the face*', including lips and eyelids. More striking effects were obtained in experiment III, in which the application of conductors to the ear and to the rectum resulted in a general muscle contraction '*stronger than in the preceding experiments*'. Such results were so unexpected that Aldini qualified them as '*almost to give an appearance of re-animation*'. Aldini then performed a series of control experiments in which he applied first ammonia to the nostrils and mouth, and second ammonia in combination with Galvanic stimulation. He noted that the application of ammonia alone produced no '*sensible action*', but when Galvanic stimulus was combined to the volatile alkali '*the convulsions appeared to be much increased by this combination, and extended from the muscles of the head, face, and neck, as far as the deltoid*'. He further commented '*The effect in this case surpassed our most sanguine expectations, and vitality might, perhaps, have been restored, if many circumstances had not rendered it impossible*'. These 'many circumstances' referred principally to the fact that George Foster had been hanged about 2 hours before the experiments began, and, furthermore, the corpse had been maintained for more than an hour after the hanging in a cold room at about -1°C (25). The *appearance of re-animation* following Galvanic stimulation was an unexpected result even for Aldini himself as revealed in his concluding remarks: '*our object in applying the treatment here described was not to produce re-animation, but merely to obtain a practical knowledge how far Galvanism might be employed as an auxiliary to other means in attempts to revive persons under similar circumstances*' (25).

The remaining experiments involved Galvanic stimulation on specifically exposed muscles and dissected nerves, but they did not yield straightforward results, as reported by Aldini himself:

> Exp. VII '…*which induced a forcible effort to clench the hand*.'; Exp. VIII '…*without producing the slightest motion*.' and '*The latter even corroded the muscle, without bringing it into action.*'; Exp. IX '…*I endeavoured to excite action in the ventricles, but without success.*' and '…*but without the slightest visible action being induced*'; Exp. X '…*the right auricle, and produced a considerable contraction*' but

'…*in the left auricle scarcely any action was exhibited.*'; Exp. XI '…*no considerable action in the muscles of the arm and leg was produced.*'; Exp. XIII '…*a very feeble action was produced...*'; Exp. XIV '…*scarcely any motion was excited in the muscles*'.

In the last experiment (XV), Aldini was still able to obtain some effects following electric stimulation of Foster's sciatic nerve '*for seven hours and a half after the execution*' (25). During these time-consuming experiments, Aldini had to renew troughs several times, claiming the assistance of a more powerful apparatus and highlighting the fact that such a lengthy set of experiments could not have been performed by the simple application of metallic coatings. He further stated, '*these coatings, invented in the first instance by Galvani, are passive*', a condition that supports the presence of a pre-existing fluid in the '*animal system.*' In contrast, he considered muscle excitation as an effect of '*the Galvanic batteries of Volta*'. These results led Aldini to conclude that Galvanism acts on both nervous and muscular systems, but that the effects produced by Volta's batteries and Galvani's simple metallic coatings are significantly different (25). This can certainly be considered a major step forward in understanding the phenomena behind electrophysiology, a rising science at that time.

From science to literature: Aldini's electric stimulations recreated into a major gothic novel

The notion of electricity was deeply embodied in the Romantic intellectual movement that characterized the arts, literature and natural sciences throughout Europe at the beginning of the 19th century. Perhaps because its true nature was poorly understood, electricity was seen as a wonderful instrument that could benefit the entire society in a vast array of fields. In medicine, for example, electricity was seen as a potent tool to diagnose and treat many types of diseases. It was also considered a central concept in several natural sciences disciplines, and some even envisaged its possible use in the development of novel mechanical devices that could significantly increase industrial growth (28). It is within this very peculiar social and cultural context that Aldini's spectacular demonstration on George Foster, which was reported in great detail in the January 22, 1803 daily issue of the newspaper *The Times*, left a strong and persistent impression in the mind of both scientists and laypersons. It is thus not surprising to see that the idea that electricity might be the source of the long-sought vital force, or the 'principle of life' began to pervade a large portion of the European society.

These ideas form the core of the highly influent gothic novel *Frankenstein; or, the Modern Prometheus* first published in 1818 by Mary Wollstonecraft Godwin, better known as Mary Shelley (10). Obsessed with the idea of controlling life and death, the young Dr. Frankenstein in Shelley's novel is a brilliant scientist who wants to go beyond the limits of science. With help of a combination of chemistry, alchemy and, above all, a decisive electrical spark, he is able to bring to life his 'Creature' made out of human remains from different corpses (Fig. 9). Let's now examine how the idea of making such a gruesome scenario the center of

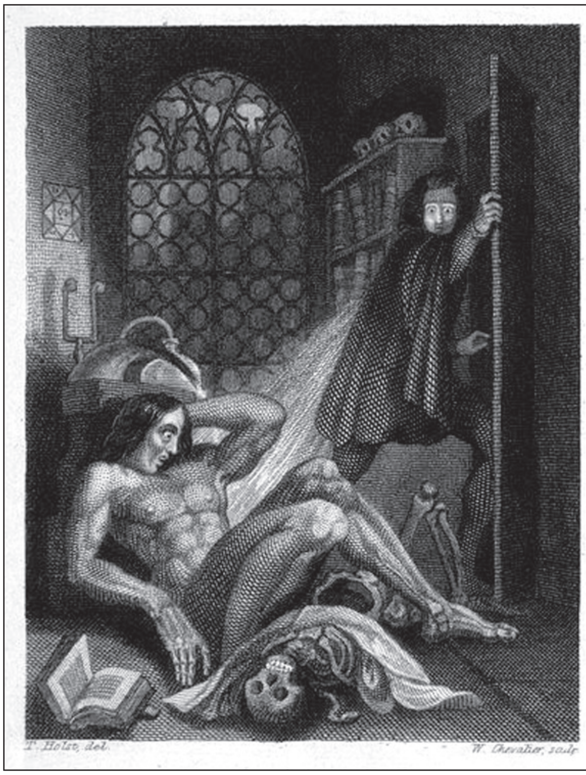

Figure 9. Frontispiece page of Mary Shelley's 1831 edition of *Frankenstein or the Modern Prometheus*. Credit: Wellcome Collection.

one of the first science-fiction novel came to the mind of an 18-years-old, well-educated British girl.

Mary Wollstonecraft Godwin was born in London on August 30, 1797 from the feminist writer Mary Wollstonecraft and the anarchist philosopher William Godwin. Thanks to her parent's connections, Mary became familiar not only with poets and writers but also with scientists, like the chemists Humphry Davy (1778-1829) and William Nicholson (1753-1815), two pioneers in the field of electricity (29). In 1814, she felt in love with the Romantic poet Percy Bysshe Shelley (1792-1822) and they married on December 30, 1816 (30). Percy was to exert a strong influence upon Mary, who was thus quite aware of the scientific milieu permeating that period. Although famous for his poetry, it is important to mention that Percy Shelley was initially trained in sciences. His college apartment at Oxford University did not contain only books but also a wide variety of scientific apparatus, including 'an electrical machine, an air-pump, galvanic troughs, a solar microscope, and large glass jars and receivers' (31).

In 1816, Mary stepsister Claire Clairmont (1798-1879), who was having a love affair with the leading figure of the Romantic movement Lord Byron (1788-1824), convinced Mary and Percy Shelley to join Byron in Switzerland with their son. They settled into the chalet Chappuis, close to the Lake Geneva, while Byron rented the Villa Diodati, followed by his young physician, John William Polidori (1795-1821). Polidori was trained in medicine at Edinburgh, where electrotherapy was highly considered, and he was quite familiar with the medical writers of the past (32). That year was characterized by severe climate abnormalities, and was defined as the 'year without summer' (33). Mary remembered that '*it proved a wet, ungenial summer, and incessant rain often confined us for days to the house*'. The heterogeneous group spent the cold and rainy nights at Villa Diodati, where they discussed various scientific issues, such as the nature of life (29). They certainly alluded to Aldini's theatrical 're-animation' on Foster's body, which raised the possibility of resuscitating dead people by electricity (34), in according to some observations that Erasmus Darwin (1731-1802) reported in 1794 on spontaneous generation and the nature of organic life (*Zoonomia* 1794). In the preface of the 1831 edition of her novel, Mary Shelly indeed reports conversations that occurred then, mainly between Byron and Percy Shelley, about '*the experiments of Dr. Darwin*' and '*galvanism*' (35). In the preface he wrote for the 1818 edition of Mary's novel, Percy Shelley mentioned that '*The event on which this fiction is founded has been supposed, by Dr. Darwin, and some of the physiological writers of Germany, as not of impossible occurrence*'. One possible German '*physiological writers*' could have been Karl August Weinhold (1782-1828), a scientist from Halle who performed a series of experiments on the nature of animal life and its relation with electricity (32).

The final conception of Frankenstein apparently goes back to a storytelling competition initiated by Byron, and in which Byron himself, as well as Percy Shelley, Polidori and Mary Shelley had to write a ghost story. Mary recalled that, after some days of '*blank incapability*', the night of June 16 (36) she had a '*waking dream*' that was at the origin of her own story: '*I saw the hideous phantasm of a man stretched out; and then, on the working of some powerful engine, show signs of life, and stir with an uneasy, half-vital motion*' (35). This description shares many similarities with what happened in London on January 17, 1803 when Aldini showed that Galvanic stimulation of the brain seemed able '*to give an appearance of re-animation*' (25). In the second chapter of Mary's novel, the echo of the electrical experiments on dead bodies became even stronger, as Dr. Frankenstein specifically refers to electricity as '*that science as being built upon secure foundations, and so worthy of my consideration*' (35).

Mary Shelley started writing her short story on two notebooks at Villa Diodati and later, thanks to Percy Shelley's encouragement, she extended it into the much longer 1818 account. It was only in 1831 that Mary published a revised version of her novel, where terms and scientific explanations were reduced, and with a new preface in which she provided '*some account of the origin of the story*' (29). A first theatrical version of Mary's bestseller was presented in 1823 at the English Opera House, in London, under the title *Presumption: or the Fate of Frankenstein*. The marked and long-lasting influence of Mary Shelley's work is attested by the fact that, so far, there have been more than 90 dramatizations and more than 70 films based on it. Furthermore, the doctor who has the capacity of resuscitating dead creature has been displayed in a multitude of cartoons and comics.

Conclusion

The impact of science on literature is almost as old as science itself. With respect to the novel *Frankenstein, or the Modern Prometheus* we have to consider that Mary Shelley was an eclectic reader, who, besides poetry, theatrical plays and novels, often plunged herself directly into scientific books. Furthermore, she regularly discussed various scientific questions with her husband Percy Shelly. Thus, she must have been fully aware of the major issues that were dealt with the English science of the Romantic era, particularly the claim that electricity might be at the origin of the life force, if not life force itself. Although indirectly, Mary came to know the details of what happened at the London College of Surgeons on January 17, 1803 when she was just 5-and-a-half years-old. This single event, together with the growing knowledge and curiosity on the theme of electricity and its deep relationship with the principle of life, undoubtedly played a key role in Shelley's elaboration of Dr. Frankenstein and his 'Creature', a sort of gothic transmutation of Giovanni Aldini and George Foster that led to the persistent myth of the mortal creator who generate life from science.

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