

Robert Bartholow (1831–1904)

Marco Cambiaghi · Stefano Sandrone

Received: 26 July 2013 / Revised: 7 August 2013 / Accepted: 8 August 2013
© Springer-Verlag Berlin Heidelberg 2013



The modern field of brain stimulation owes much to the American Robert Bartholow (sometimes also referred to as Roberts Bartholow [4]), who was one of the first to report the effects of electrical current stimulation to the cortex in conscious humans [1]. He was therefore an important

pioneer in translating bioelectricity research from animals to humans.

Robert Bartholow was born to Jeremiah and Pleasant Bartholow (née Peddicord) in New Windsor, Maryland [3] on 28 November 1831. Thanks to his parents' efforts he was able to study at Calvert College (now New Windsor College) in Maryland. Bartholow was a brilliant student and young assistant instructor of chemistry, and received the degree of Master of Arts in 1848 [3]. He was an excellent student in the Latin and Greek classics but he also devoted himself to the use of French and German with great success [5]. He enrolled in Medicine at the University of Maryland and received his degree in 1852. He started working as a private medical practitioner in Baltimore clinics and hospitals, but he then decided to join the Army Medical staff. In 1855, he finally realized his dream. He ranked first among the few selected from numerous candidates, as Assistant Surgeon in the U.S. Army, Recorder of the Board and Medical Purveyor for the Army of Potomac.

He initially stayed on the frontier in Utah, Minnesota, and in New Mexico during the Mormon Rebellion, where he was serving when the rebellion broke out. During the War of Rebellion he served as head of the General Hospital of Baltimore, New York Harbor, Washington, Chattanooga and Nashville [4], thus achieving a wide-range of on-field experience. In this period, by order of his superior officers, he wrote 'A Manual of Instruction for Enlisting and Discharging Soldiers', that became the official handbook for the US Government Recruiting and Discharging Stations [5].

In 1862, Bartholow married Maria Walker and in 1864, after the birth of the first of their two daughters, he decided to leave the army. He came back to a private practice and got a professorship in Medical Chemistry at the Medical

The authorship of this article is alphabetical, as we judge our contributions to be equal.

M. Cambiaghi (✉)
Department of Neuroscience, University of Turin,
C.so Raffaello 30, 10125 Turin, Italy
e-mail: marco.cambiaghi@unito.it

S. Sandrone
NATBRAINLAB-Neuroanatomy and Tractography Brain
Laboratory, Department of Forensic and Neurodevelopmental
Sciences, Institute of Psychiatry, King's College,
SE5 8AF, London, UK
e-mail: sandronestefano@ini.ethz.ch

S. Sandrone
Institute of Neuroinformatics, University of Zurich and ETH
Zurich, 8057 Zurich, Switzerland

College of Ohio in Cincinnati, held until 1879. In 1866, he also joined the Good Samaritan Hospital, where he soon acquired an extensive practice, connected himself to a number of hospitals and gained a reputation as a clinical teacher of medicine [5]. In 1869, he accepted the chair of Professor of Materia Medica and Therapeutics and of Clinical Medicine at the same Medical College. Five years later, he was appointed Professor of the Theory and Practice of Medicine [9]. In 1875, Bartholow was among the founders of the American Neurological Association of which he became president in 1881 [9]. In 1879, he decided to move to Jefferson Medical College in Philadelphia, where he became the dean of faculty. Within a few years, Bartholow had risen to a position of great popularity in the American medical profession. He was member of the Ohio State Medical Society, the Cincinnati Academy of Medicine, the American Neurological Society and corresponding member of the New York Society of Neurology and Electrology. Rather reserved, often sarcastic, gifted with remarkable analytical thinking, he is claimed to have never had an intimate friend or even a close associate [3]. His favorite weapons in any discussion were analogy, logic and sarcasm [5].

Fascinated and inspired by the experiments performed on animal brains by the anatomist and anthropologist Gustav Fritsch (1838–1927) and the neurologist and neuropsychiatrist Eduard Hitzig (1839–1907), both from Germany, and the Scottish neurologist David Ferrier (1843–1928) [7], Bartholow elucidated functional and anatomical localization of human motor areas [8], applying Faradic electrical currents to a patient's cortex [6]. In 1874, he published an article in the *American Journal of the Medical Sciences*, entitled “Experimental investigations into the functions of the human brain”. A rapidly expanding epithelioma was eroding the skull of a 30-year-old servant, Marta Rafferty, who gave her consent to Bartholow for performing brain stimulation experiments. The 2-inch-diameter exposed brain allowed Bartholow to insert metal electrodes and apply faradic currents [4, 8], stimulating the dura and then the cortex, just behind the Rolandic fissure. He reported a series of six observations, the main one reporting ‘distinct muscular contractions’ and tingling contralateral to the stimulated hemisphere [1]. In so doing, he had invaded what some considered the human ‘sacred organ’ and was held responsible for Rafferty's death. However, he had confirmed for the first time in an awake human what Fritsch and Hitzig and Ferrier had previously observed in lower animals. Bartholow was severely criticized on the ethical aspect of his investigations, particularly by the American Medical Association, a society which he regularly joined as member. Probably this

was the reason he had to leave Cincinnati [8]. In response to an editorial in the *British Medical Journal*, he stated that the patient consented to having the experiments performed and, according to the new knowledge, “to repeat such experiments would be in the highest degree criminal” [2]. His pioneering work was stronger than the critics, and in 1893 he became Emeritus Professor at Jefferson Medical College in Philadelphia [9].

It is not entirely clear who was first to stimulate a human's brain electrically. Some authors report it was Fritsch and Hitzig, while others attributed priority to Bartholow, whose report appears to be the clearest and most detailed [8]. However, this is still an open question.

Remarkably, Bartholow was also a fine and successful writer: over his entire career, he wrote several books on the medical aspects of military enrollment and life. Some became bestsellers, adopted as didactic textbooks that won awards such as those from Connecticut Medical Society, the Fiske Fund, and the American Medical Association itself. Bartholow died at his home in Philadelphia on 10 May 1904, at age 72.

Acknowledgments The authors wish to thank Jenna Nankin for editing assistance, and the University of Cincinnati and Thomas Jefferson University of Philadelphia for information and material on Robert Bartholow.

Conflicts of interest The corresponding authors state that there is no conflict of interest.

References

1. Bartholow R (1874) Experimental Investigations into the Functions of the Human Brain *Amer. J Med Sci* 66:305–313
2. Bartholow R (1874b) Experiments on the functions of the human brain. *Br Med J* i: 727
3. Harris LJ, Almerigi JB (2009) Probing the human brain with stimulating electrodes: the story of Roberts Bartholow's (1874) experiment on Mary Rafferty. *Brain Cogn* 70:92–115
4. Holmes GL (1982) Roberts Bartholow. In search of anatomic localization. *N Y State J Med* 82:238–241
5. Juettner O (1909) 1785-1909: Daniel Drake and his followers. Harvey Pub. Co., Cincinnati, pp 260–267
6. Morgan JP (1982) The first reported case of electrical stimulation of the human brain. *J Hist Med Allied Sci* 37:51–64
7. Sandrone S, Zanin E (2013). David Ferrier (1843–1928). *J Neurol*, Epub ahead of print
8. Thomas RK, Young CD (1993) A note on the early history of electrical stimulation of the human brain. *J Gen Psychol* 120:73–81
9. Zago S, Ferrucci R, Fregni F, Priori A (2008) Bartholow, Sciamanna, Alberti: pioneers in the electrical stimulation of the exposed human cerebral cortex. *Neuroscientist* 14:521–528