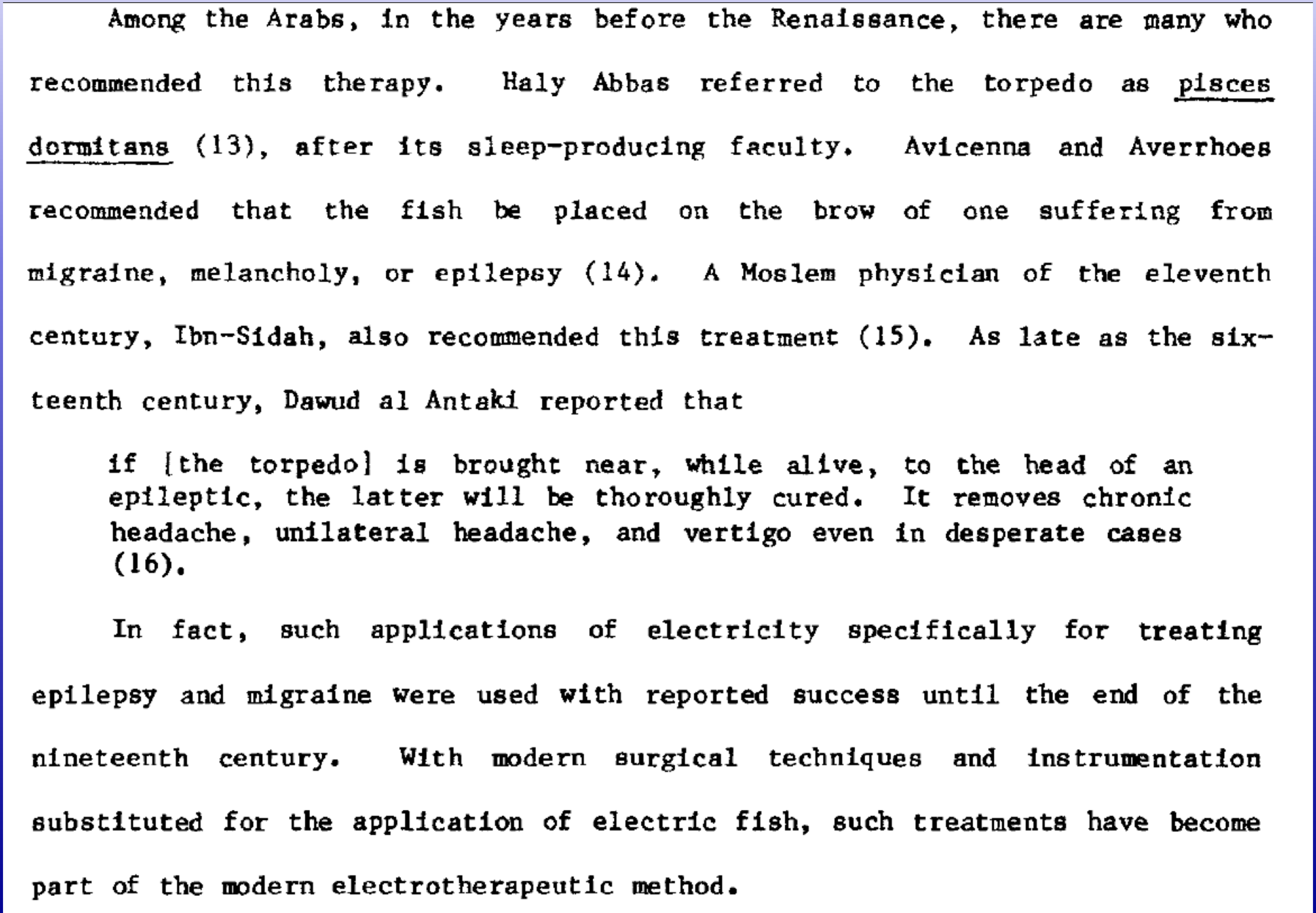
Dennis Stillings

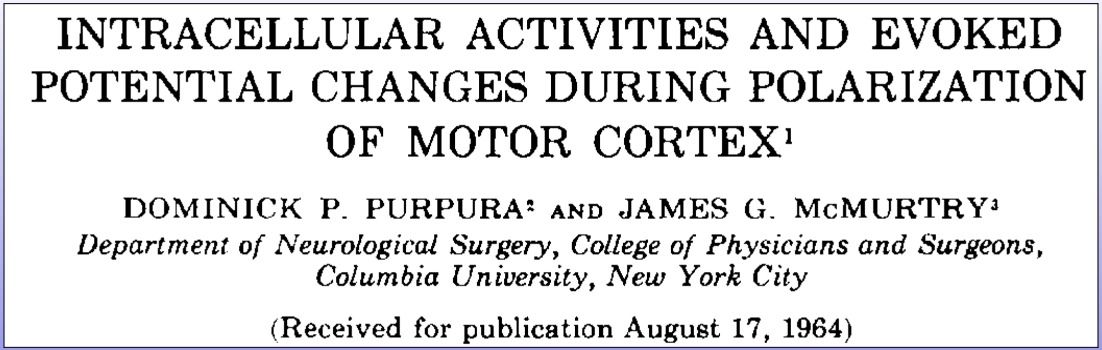
JOURNAL OF BIOELECTRICITY, 2(2&3), 181-186 (1983)



Among the Arabs, in the years before the Renaissance, there are many who recommended this therapy. Haly Abbas referred to the torpedo as <u>pisces dormitans</u> (13), after its sleep-producing faculty. Avicenna and Averrhoes recommended that the fish be placed on the brow of one suffering from migraine, melancholy, or epilepsy (14). A Moslem physician of the eleventh century, Ibn-Sidah, also recommended this treatment (15). As late as the sixteenth century, Dawud al Antaki reported that

> if [the torpedo] is brought near, while alive, to the head of an epileptic, the latter will be thoroughly cured. It removes chronic headache, unilateral headache, and vertigo even in desperate cases (16).

In fact, such applications of electricity specifically for treating epilepsy and migraine were used with reported success until the end of the nineteenth century. With modern surgical techniques and instrumentation substituted for the application of electric fish, such treatments have become part of the modern electrotherapeutic method.



INTRACELLULAR ACTIVITIES AND EVOKED POTENTIAL CHANGES DURING POLARIZATION OF MOTOR CORTEX[1]

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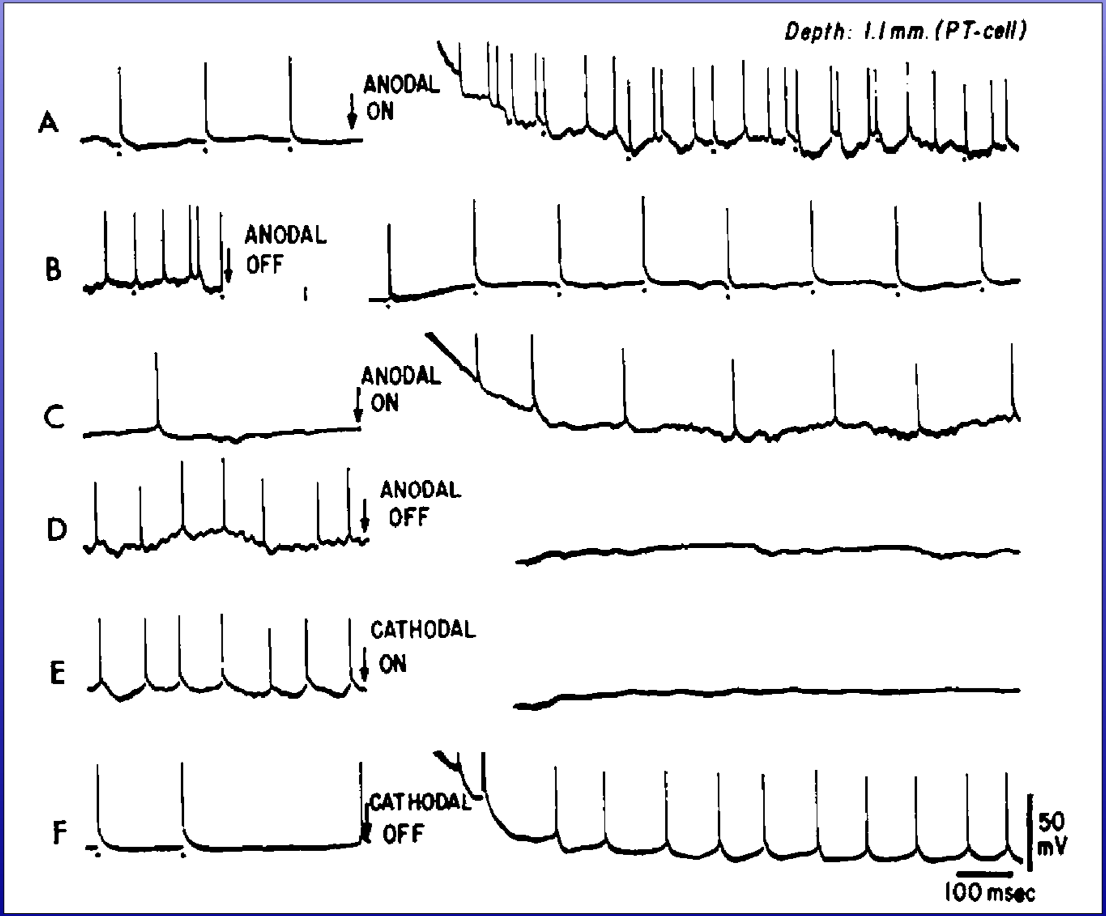
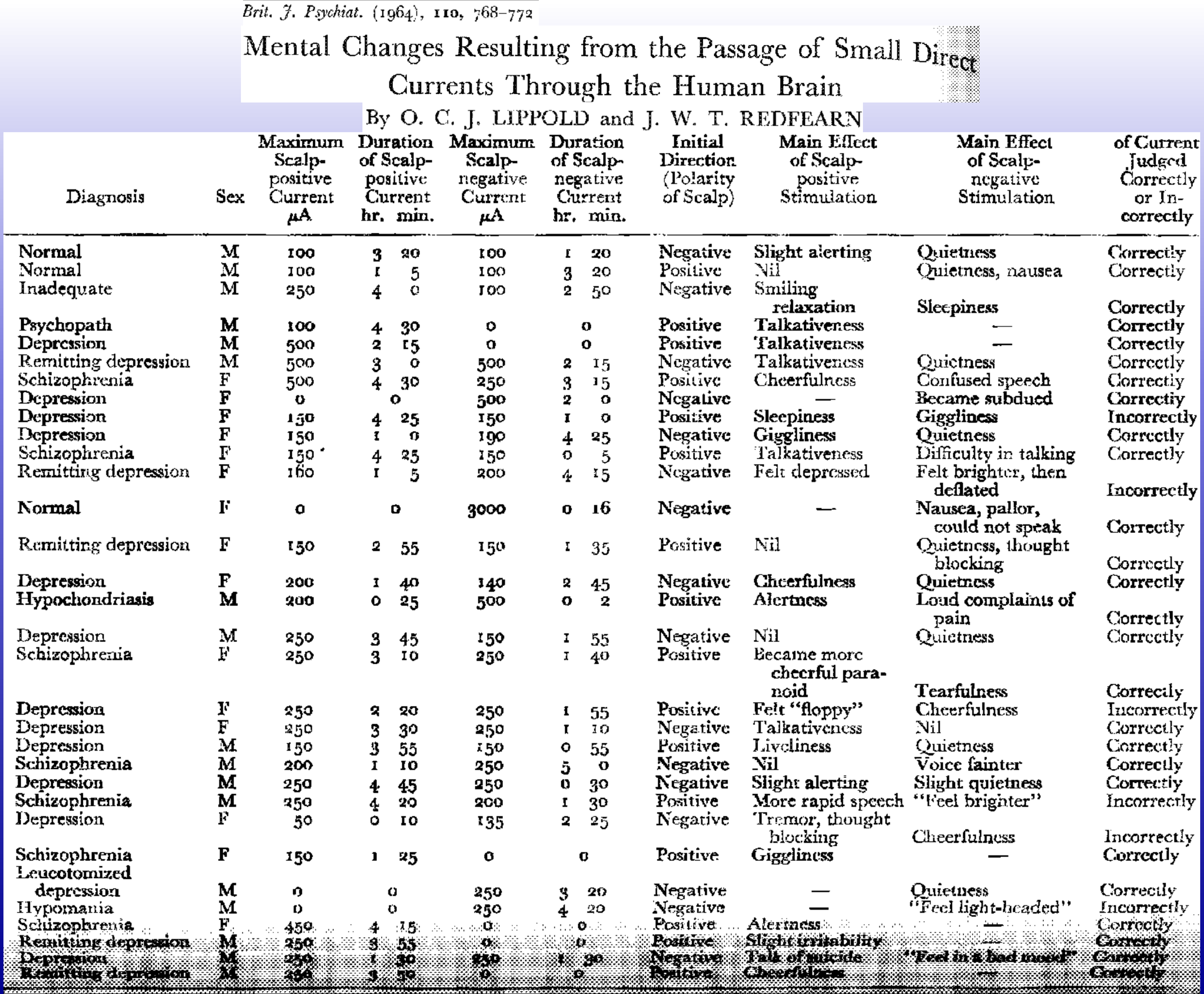
(Received for publication August 17, 1964)



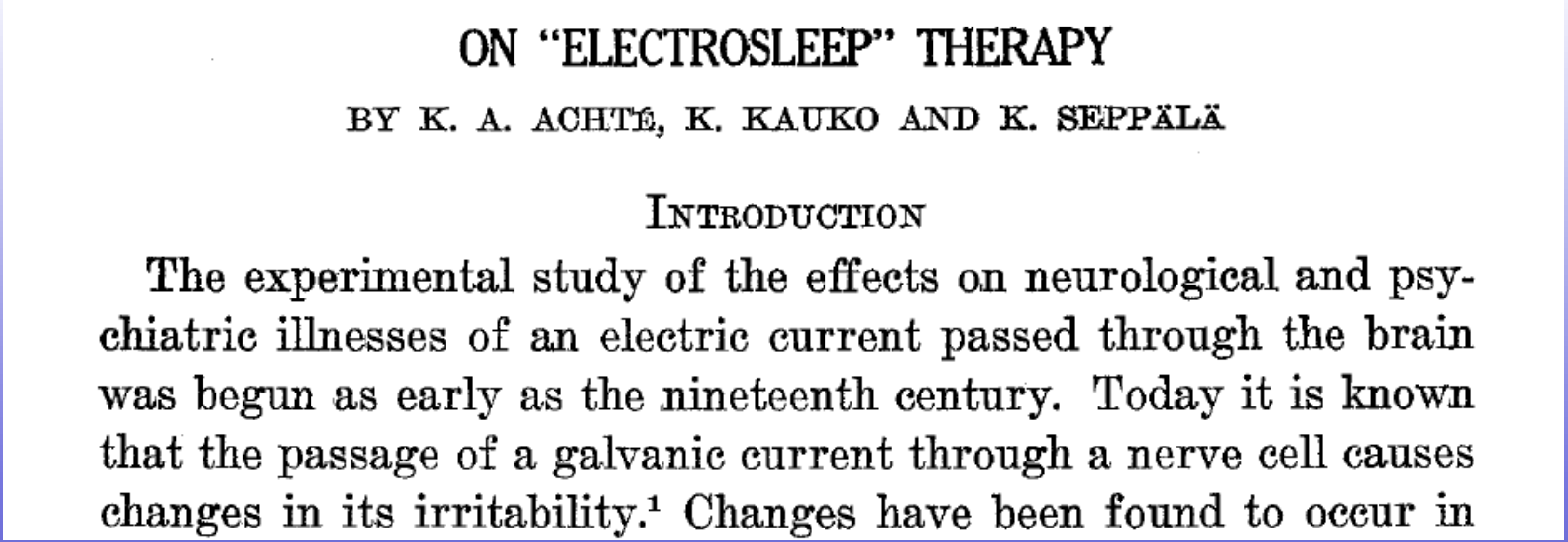


Brit. J. Psychiat. (1964), 110, 768–772

Mental Changes Resulting from the Passage of Small Direct Currents Through the Human Brain

By O. C. J. LIPPOLD and J. W. T. REDFEARN

Diagnosis	Sex	Maximum Scalp-positive Current µA	Duration of Scalp-positive Current hr. min.	Maximum Scalp-negative Current µA	Duration of Scalp-negative Current hr. min.	Initial Direction (Polarity of Scalp)	Main Effect of Scalp-positive Stimulation	Main Effect of Scalp-negative Stimulation	of Current Judged Correctly or Incorrectly
Normal	M	100	3 20	100	1 20	Negative	Slight alerting	Quietness	Correctly
Normal	M	100	1 5	100	3 20	Positive	Nil	Quietness, nausea	Correctly
Inadequate	M	250	4 0	100	2 50	Negative	Smiling relaxation	Sleepiness	Correctly
Psychopath	M	100	4 30	0	0	Positive	Talkativeness	—	Correctly
Depression	M	500	2 15	0	0	Positive	Talkativeness	—	Correctly
Remitting depression	M	500	3 0	500	2 15	Negative	Talkativeness	Quietness	Correctly
Schizophrenia	F	500	4 30	250	3 15	Positive	Cheerfulness	Confused speech	Correctly
Depression	F	0	0	500	2 0	Negative	—	Became subdued	Correctly
Depression	F	150	4 25	150	1 0	Positive	Sleepiness	Giggliness	Incorrectly
Depression	F	150	1 0	190	4 25	Negative	Giggliness	Quietness	Correctly
Schizophrenia	F	150	4 25	150	0 5	Positive	Talkativeness	Difficulty in talking	Correctly
Remitting depression	F	160	1 5	200	4 15	Negative	Felt depressed	Felt brighter, then deflated	Incorrectly
Normal	F	0	0	3000	0 16	Negative	—	Nausea, pallor, could not speak	Correctly
Remitting depression	F	150	2 55	150	1 35	Positive	Nil	Quietness, thought blocking	Correctly
Depression	F	200	1 40	140	2 45	Negative	Cheerfulness	Quietness	Correctly
Hypochondriasis	M	200	0 25	500	0 2	Positive	Alertness	Loud complaints of pain	Correctly
Depression	M	250	3 45	150	1 55	Negative	Nil	Quietness	Correctly
Schizophrenia	F	250	3 10	250	1 40	Positive	Became more cheerful paranoid	Tearfulness	Correctly
Depression	F	250	2 20	250	1 55	Positive	Felt "floppy"	Cheerfulness	Incorrectly
Depression	F	250	3 30	250	1 10	Negative	Talkativeness	Nil	Correctly
Depression	M	150	3 55	150	0 55	Positive	Liveliness	Quietness	Correctly
Schizophrenia	M	200	1 10	250	5 0	Negative	Nil	Voice fainter	Correctly
Depression	M	250	4 45	250	0 30	Negative	Slight alerting	Slight quietness	Correctly
Schizophrenia	M	250	4 20	200	1 30	Positive	More rapid speech	"Feel brighter"	Incorrectly
Depression	F	50	0 10	135	2 25	Negative	Tremor, thought blocking	Cheerfulness	Incorrectly
Schizophrenia	F	150	1 25	0	0	Positive	Giggliness	—	Correctly
Leucotomized depression	M	0	0	250	3 20	Negative	—	Quietness	Correctly
Hypomania	M	0	0	250	4 20	Negative	—	"Feel light-headed"	Incorrectly
Schizophrenia	F	450	4 15	0	0	Positive	Alertness	—	Correctly
Remitting depression	M	250	3 55	0	0	Positive	Slight irritability	—	Correctly
Depression	M	250	1 30	250	1 30	Negative	Talk of suicide	"Feel in a bad mood"	Correctly
Remitting depression	M	250	3 50	0	0	Positive	Cheerfulness	—	Correctly

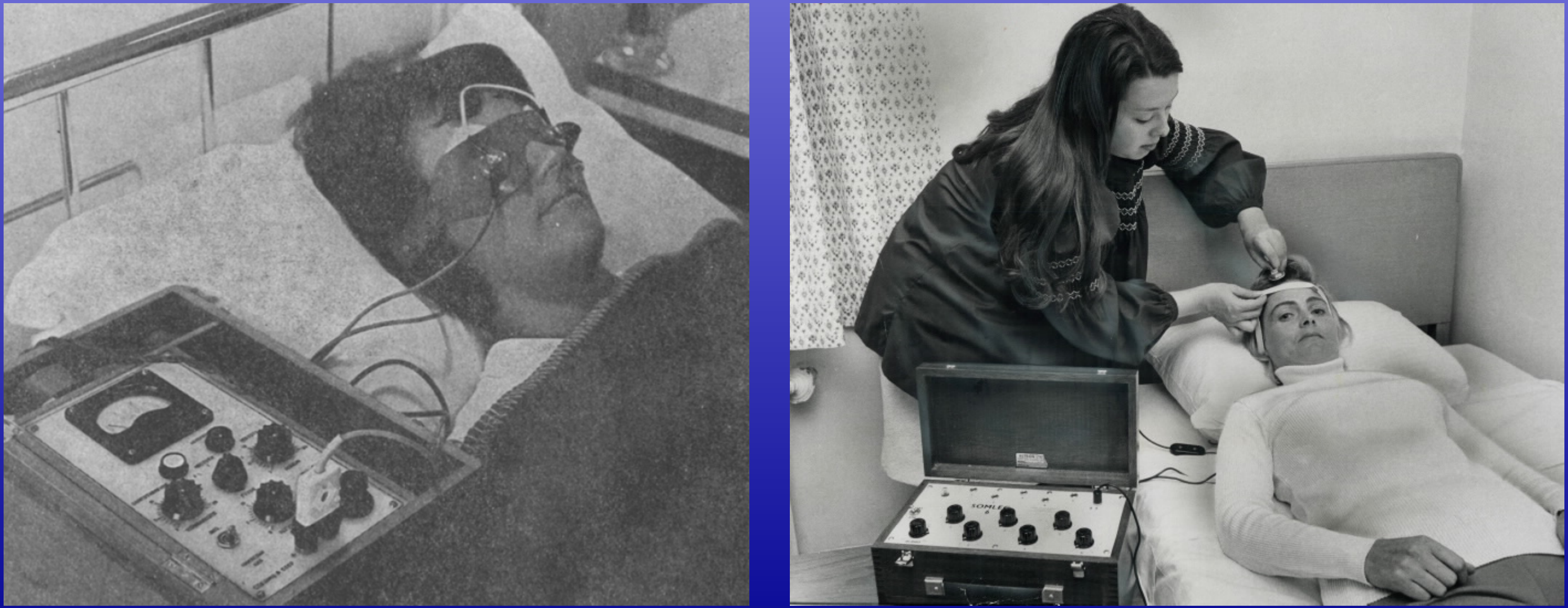


ON "ELECTROSLEEP" THERAPY

BY K. A. ACHTÉ, K. KAUKO AND K. SEPPÄLÄ

INTRODUCTION

The experimental study of the effects on neurological and psychiatric illnesses of an electric current passed through the brain was begun as early as the nineteenth century. Today it is known that the passage of a galvanic current through a nerve cell causes changes in its irritability.[1] Changes have been found to occur in



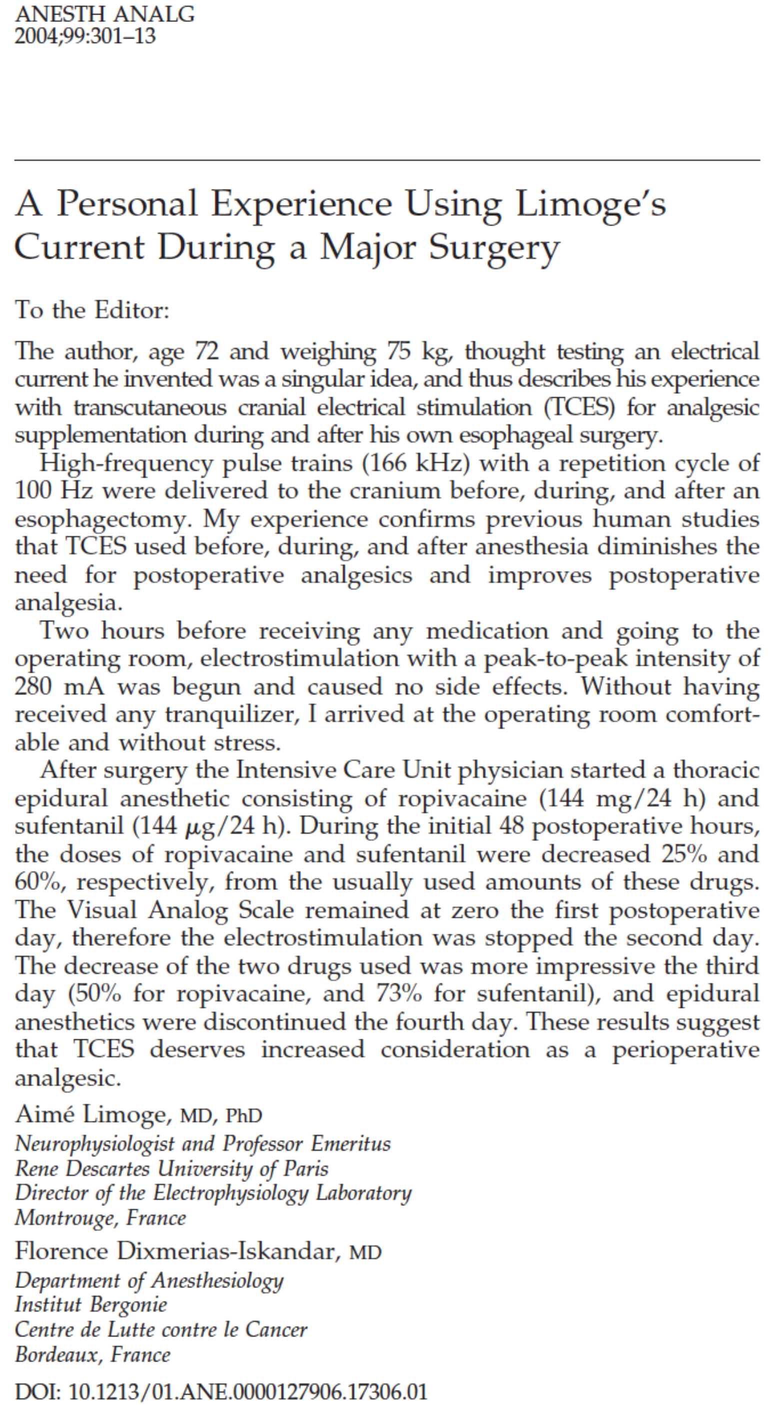
AN EVALUATION OF
ELECTROANESTHESIA AND ELECTROSLEEP

Report of the *ad hoc* Committee
on Electric Stimulation of the Brain

Division of Medical Sciences
Assembly of Life Sciences
National Research Council

Supported by
The Food and Drug Administration
Contract FDA 70-22, Task Order No. 20

DEC 14 1974



ANESTH ANALG
2004;99:301–13

A Personal Experience Using Limoge's Current During a Major Surgery

To the Editor:

The author, age 72 and weighing 75 kg, thought testing an electrical current he invented was a singular idea, and thus describes his experience with transcutaneous cranial electrical stimulation (TCES) for analgesic supplementation during and after his own esophageal surgery.

High-frequency pulse trains (166 kHz) with a repetition cycle of 100 Hz were delivered to the cranium before, during, and after an esophagectomy. My experience confirms previous human studies that TCES used before, during, and after anesthesia diminishes the need for postoperative analgesics and improves postoperative analgesia.

Two hours before receiving any medication and going to the operating room, electrostimulation with a peak-to-peak intensity of 280 mA was begun and caused no side effects. Without having received any tranquilizer, I arrived at the operating room comfortable and without stress.

After surgery the Intensive Care Unit physician started a thoracic epidural anesthetic consisting of ropivacaine (144 mg/24 h) and sufentanil (144 μg/24 h). During the initial 48 postoperative hours, the doses of ropivacaine and sufentanil were decreased 25% and 60%, respectively, from the usually used amounts of these drugs. The Visual Analog Scale remained at zero the first postoperative day, therefore the electrostimulation was stopped the second day. The decrease of the two drugs used was more impressive the third day (50% for ropivacaine, and 73% for sufentanil), and epidural anesthetics were discontinued the fourth day. These results suggest that TCES deserves increased consideration as a perioperative analgesic.

Aimé Limoge, MD, PhD
Neurophysiologist and Professor Emeritus
Rene Descartes University of Paris
Director of the Electrophysiology Laboratory
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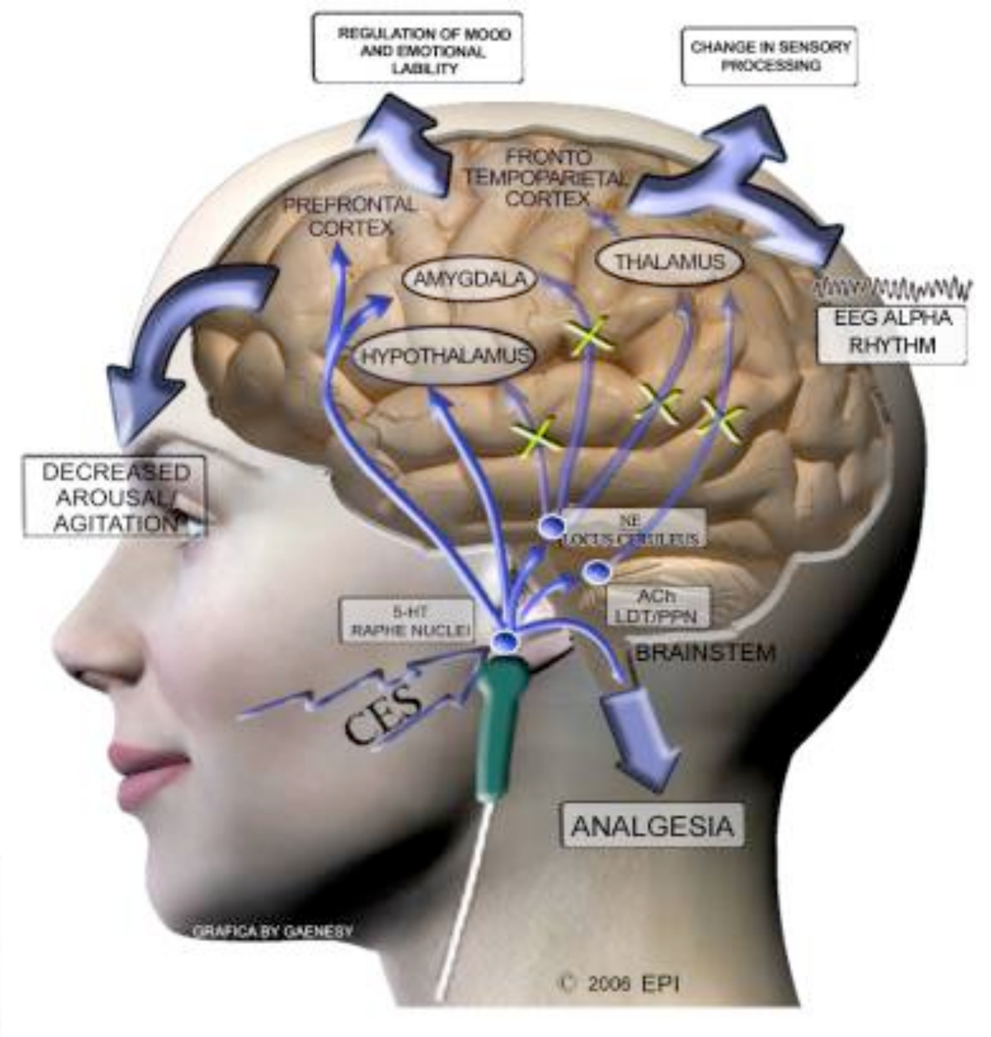
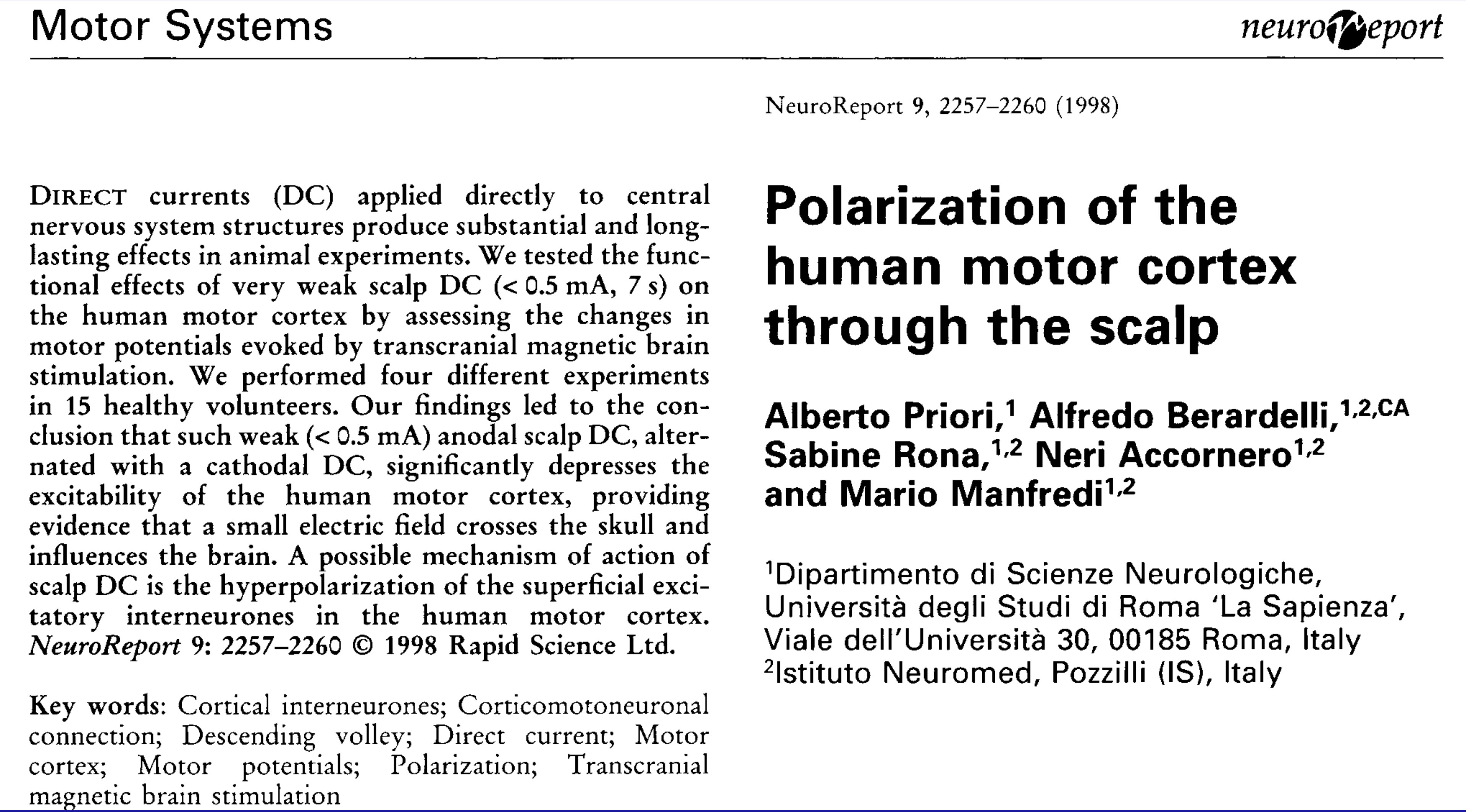
Department of Anesthesiology
Institut Bergonie
Centre de Lutte contre le Cancer
Bordeaux, France

DOI: 10.1213/01.ANE.0000127906.17306.01

Cranial electrotherapy stimulation





Motor Systems
neuroReport

NeuroReport 9, 2257–2260 (1998)

Polarization of the human motor cortex through the scalp

Alberto Priori,[1] Alfredo Berardelli,[1,2,CA] Sabine Rona,[1,2] Neri Accornero[1,2] and Mario Manfredi[1,2]

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Viale dell'Università 30, 00185 Roma, Italy
[2]Istituto Neuromed, Pozzilli (IS), Italy

DIRECT currents (DC) applied directly to central nervous system structures produce substantial and long-lasting effects in animal experiments. We tested the functional effects of very weak scalp DC (< 0.5 mA, 7 s) on the human motor cortex by assessing the changes in motor potentials evoked by transcranial magnetic brain stimulation. We performed four different experiments in 15 healthy volunteers. Our findings led to the conclusion that such weak (< 0.5 mA) anodal scalp DC, alternated with a cathodal DC, significantly depresses the excitability of the human motor cortex, providing evidence that a small electric field crosses the skull and influences the brain. A possible mechanism of action of scalp DC is the hyperpolarization of the superficial excitatory interneurones in the human motor cortex. *NeuroReport* 9: 2257–2260 © 1998 Rapid Science Ltd.

Key words: Cortical interneurones; Corticomotoneuronal connection; Descending volley; Direct current; Motor cortex; Motor potentials; Polarization; Transcranial magnetic brain stimulation

Journal of Physiology (2000), **527.3**, *pp.*633–639

Excitability changes induced in the human motor cortex by weak transcranial direct current stimulation

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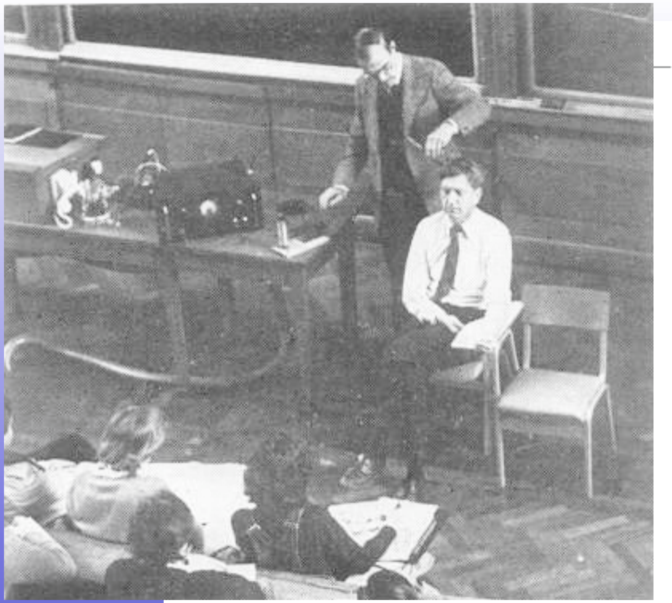
(Received 8 May 2000; accepted after revision 5 June 2000)

1. In this paper we demonstrate in the intact human the possibility of a non-invasive modulation of motor cortex excitability by the application of weak direct current through the scalp.
2. Excitability changes of up to 40%, revealed by transcranial magnetic stimulation, were accomplished and lasted for several minutes after the end of current stimulation.
3. Excitation could be achieved selectively by anodal stimulation, and inhibition by cathodal stimulation.
4. By varying the current intensity and duration, the strength and duration of the after-effects could be controlled.
5. The effects were probably induced by modification of membrane polarisation. Functional alterations related to post-tetanic potentiation, short-term potentiation and processes similar to postexcitatory central inhibition are the likely candidates for the excitability changes after the end of stimulation. Transcranial electrical stimulation using weak current may thus be a promising tool to modulate cerebral excitability in a non-invasive, painless, reversible, selective and focal way.



Stimulation of the cerebral cortex in the intact human subject

P. A. Merton & H. B. Morton

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One of the most fertile methods of investigating the brain is to stimulate a part of it electrically and observe the results. So far, however, use of the method in man has been restricted by the necessity of opening the skull surgically to apply the electrodes. Much could be done, both with healthy subjects and with neurological patients, if it were feasible to stimulate through electrodes on the scalp, although the localization of the stimulus on the cortex will always be much less sharp than with electrodes on the brain surface. In an intact man, however, the brain is protected from electricity by the skull and by the scalp, both of which normally offer considerable resistance. Furthermore, the cerebral cortex does not have a particularly low electrical threshold. It is probably for these reasons (despite an occasional contrary claim[1]) that attempts to stimulate the brain by applying stimuli from conventional stimulators to the scalp have been stopped by pain or have otherwise failed. These obstacles have now begun to yield. Recently, it was found that, on stimulating muscles in the human hand[2] without any special preparation of the skin, the effective resistance fell to low values if brief but very high voltage shocks were used. Applying the same technique to the head, it has now proved possible at the first attempt to stimulate two areas of the human cortex, without undue discomfort.

The stimulating electrodes were ordinary stick-on silver-cup electroencephalogram electrodes of 1 cm diameter, filled with electrode jelly. For the motor area, one electrode was applied initially over the surface marking of the arm area of the motor cortex and the other 4 cm in front. To stimulate, a 0.1-μF condenser charged to up to ~2,000 V was discharged through the electrodes using a Morse key. The electrode over the motor area was the positive. A shunt resistance of 100 Ω ensured that the time constant of discharge was less than 10 μs.

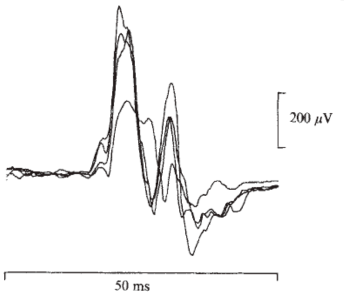

Fig. 1 Stimulation of the arm area of the motor cortex. The records shown are of action potentials from the contracting muscles in the forearm. Stimulation is at the start of the sweep. Four records are superimposed. The latency of responses was 16 ms. (Subject P.A.M.)

Stimulation showed itself by twitch-like movements of the opposite middle and index fingers, or, with the active electrode over the leg area, of the foot. In one subject (height 1.88 m), muscle action potentials recorded through surface electrodes over the active muscles showed fairly sharp latencies of 16 ms for the forearm muscles (Fig. 1) and 34 ms for the muscles in the lower leg. These values agree with those obtained by stimulating the exposed human motor cortex or the nerve fibres leaving it[3,4].

With electrodes on the back of the head, over the visual area of the cortex, illusory visual sensations ('phosphenes') were experienced. Larger voltages were necessary for the visual area than for the motor area. For each stimulus the phosphene was very brief. It appeared near the centre of the visual field as a patch, with indefinite edges, subtending some 5°, containing one or a few, sharp, bright sinuous lines. The main evidence that such phosphenes are caused by stimulation of the visual cortex is that they only occurred with electrodes over the visual area and that, within that region, the position of a phosphene in the visual field moved with the position of the stimulating electrodes in a manner that conformed with the known mapping of the visual field on the cortex (half-fields reversed and upside down, with a large area for the centre of the field on the occipital poles). Thus, with a horizontal pair of electrodes above the occipital pole (6 cm above the inion), the phosphene was below the fixation point. It moved upwards roughly to the fixation point when the electrodes were moved downwards (to 3 cm above the inion). Similarly, the phosphenes appeared mainly on the right with electrodes to the left of the mid-line, and vice versa. They disappeared altogether when the electrodes were moved away more than a few centimetres from the occiput.

Another important observation is that the phosphenes described did not disappear when the eyeballs were pressed on until sight was lost in both eyes, so they were not due to the excitation of the retina by spread of current. Such excitation occurs very readily, as the retina has a low electrical threshold; but the resulting phosphenes fill diffusely much of the visual field, are without structure, are not specially related to stimulation over the visual area, and disappear with pressure-blinding. Thus, although both may be seen simultaneously, phosphenes from current spread to the retina are readily distinguished from the phosphenes we attribute to stimulation of the visual cortex.

Received 6 February; accepted 18 March 1980.

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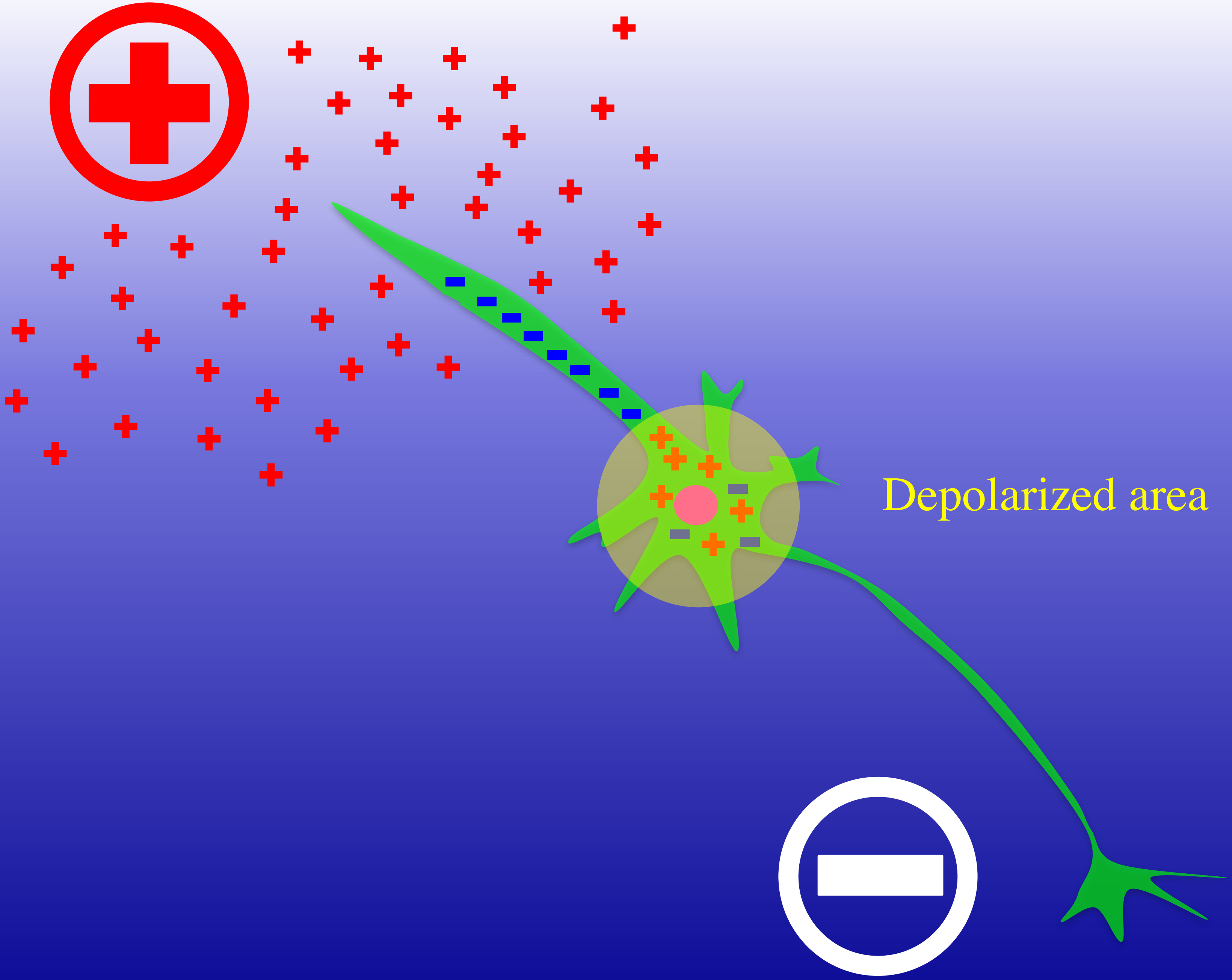
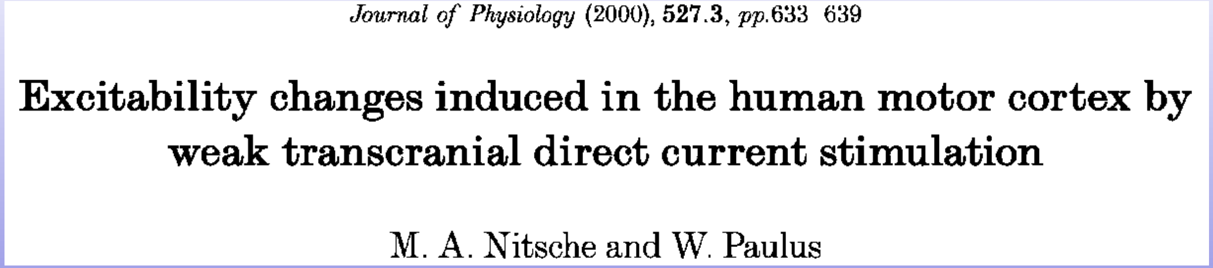


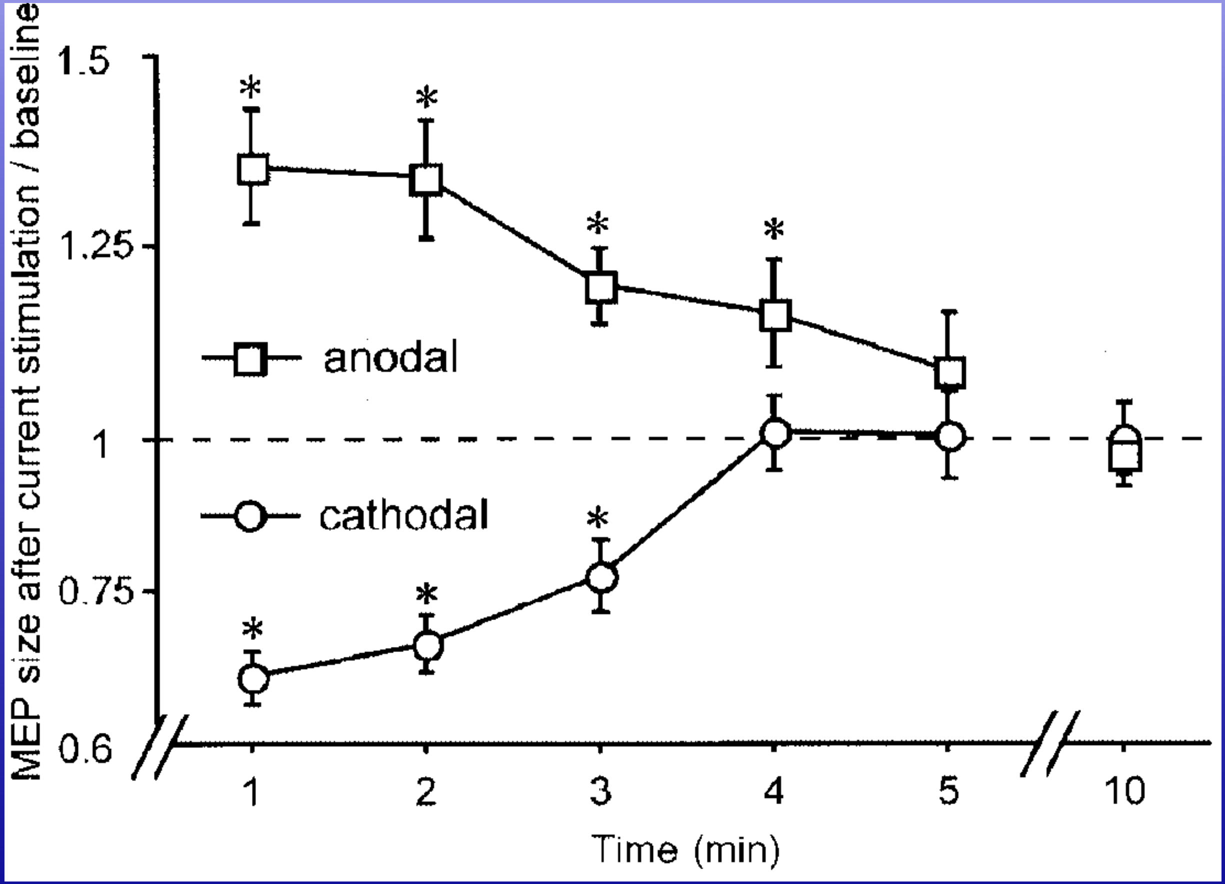
Depolarized area



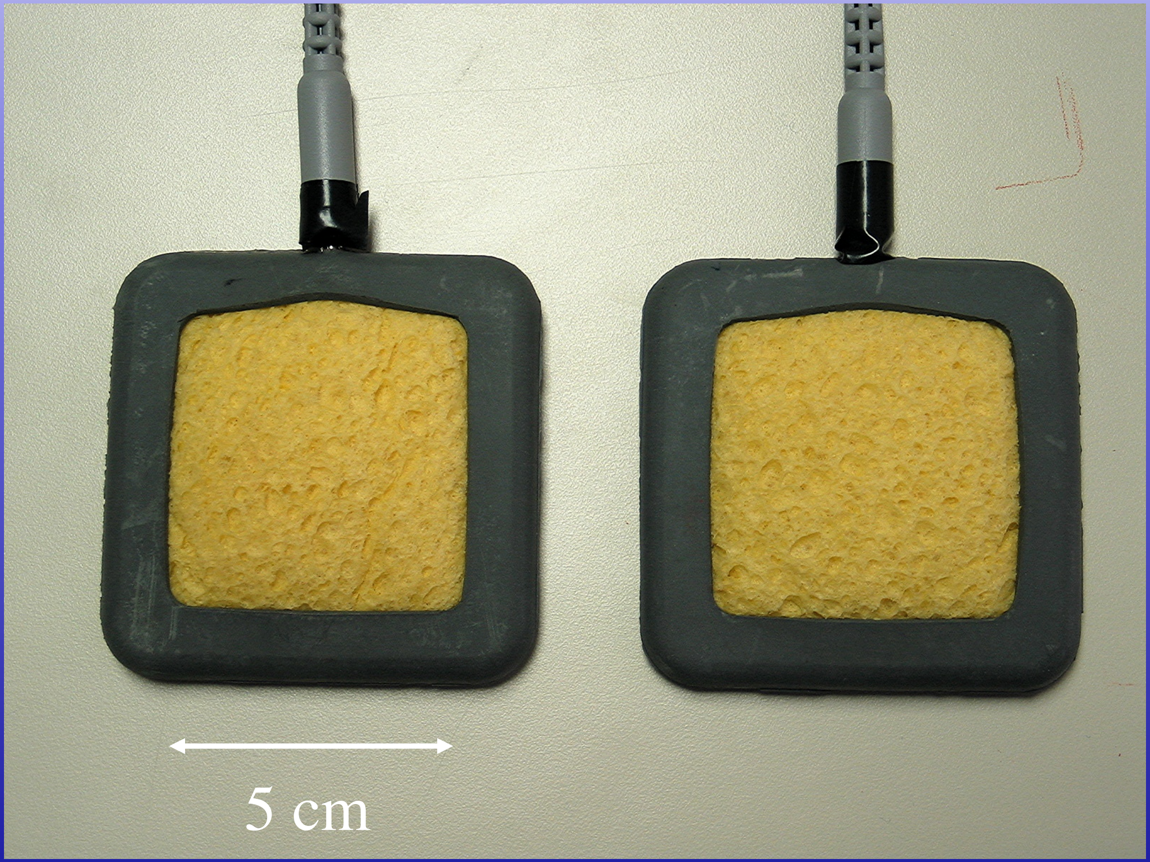
Journal of Physiology (2000), **527.3**, *pp.*633 639

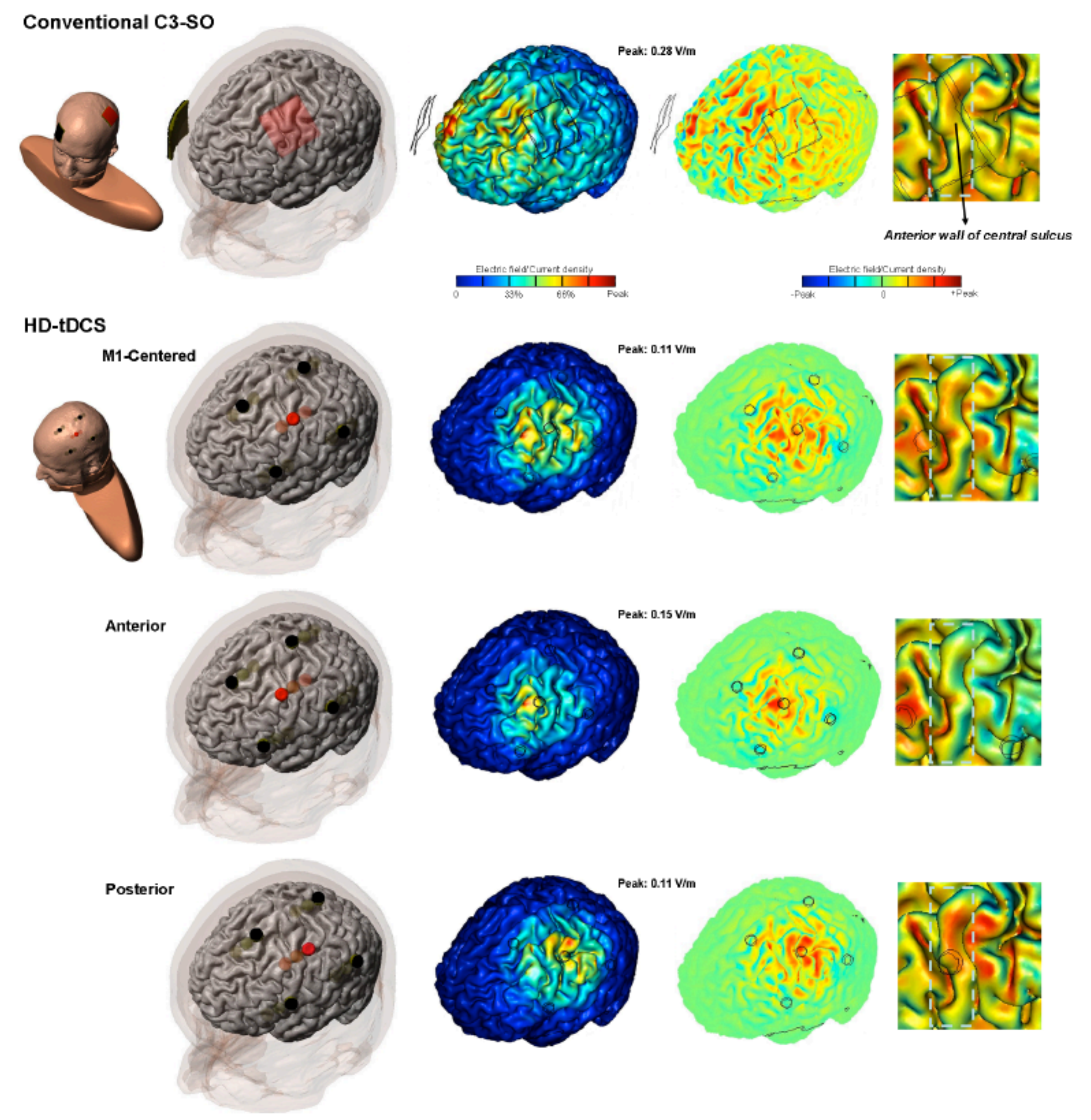
Excitability changes induced in the human motor cortex by weak transcranial direct current stimulation

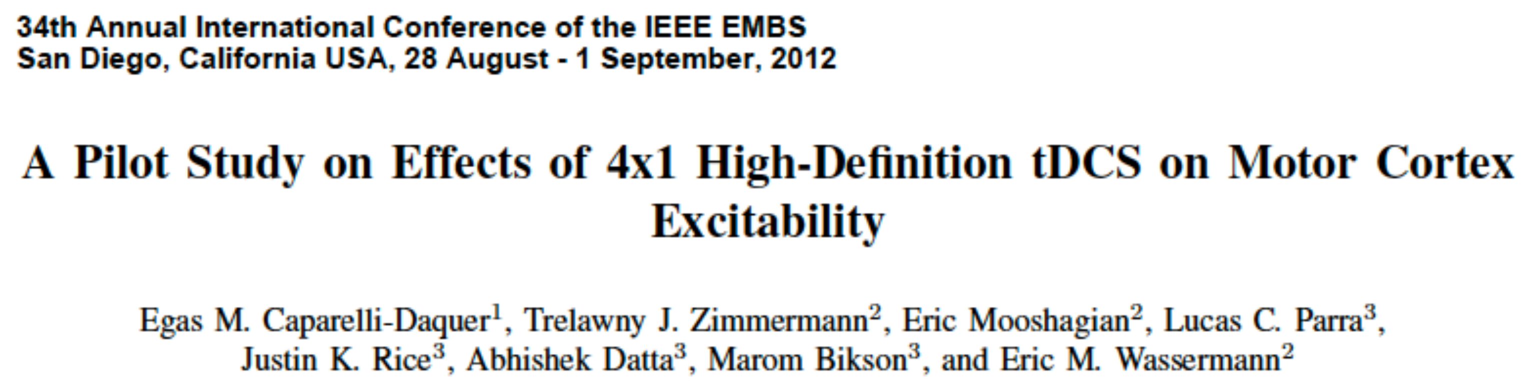
M. A. Nitsche and W. Paulus



DC brain polarization



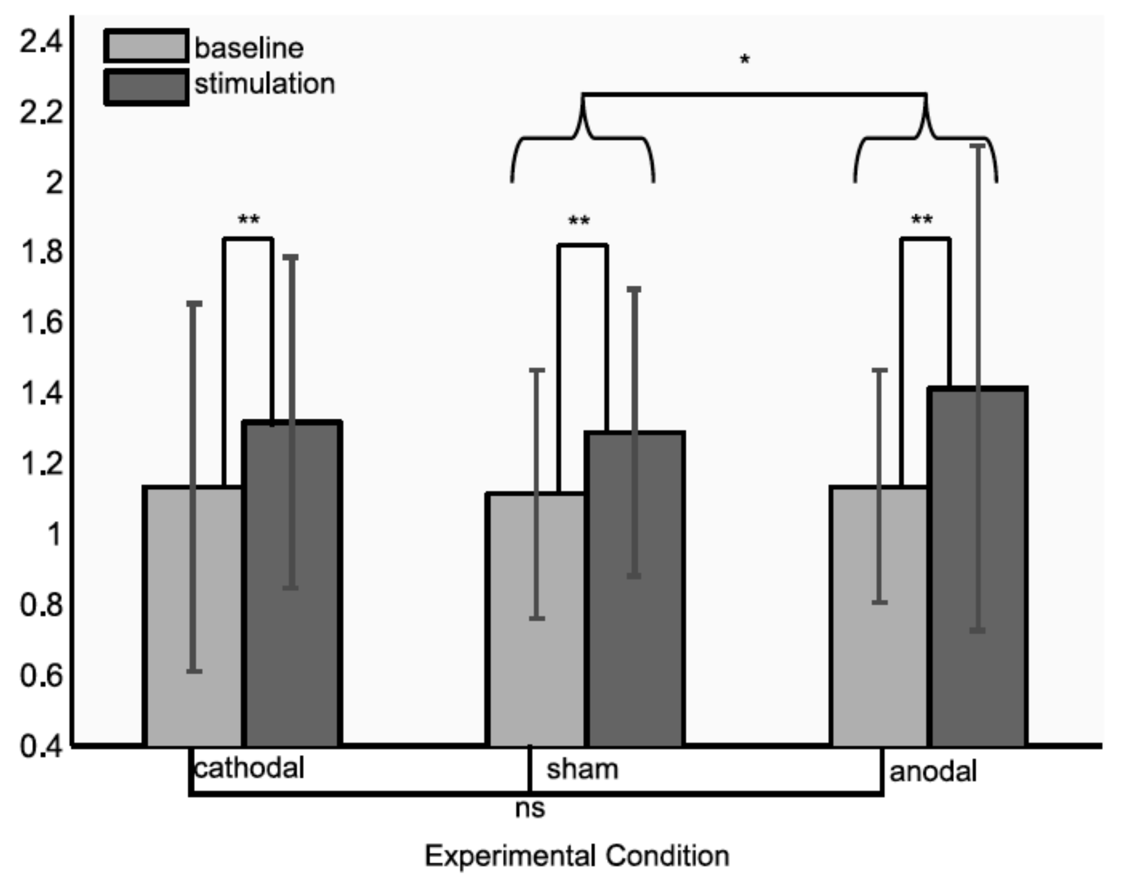

Conventional C3-SO
Peak: 0.28 V/m
Anterior wall of central sulcus
Electric field/Current density
0
33%
66%
Peak
Electric field/Current density
-Peak
0
+Peak
HD-tDCS
M1-Centered
Peak: 0.11 V/m
Anterior
Peak: 0.15 V/m
Posterior
Peak: 0.11 V/m

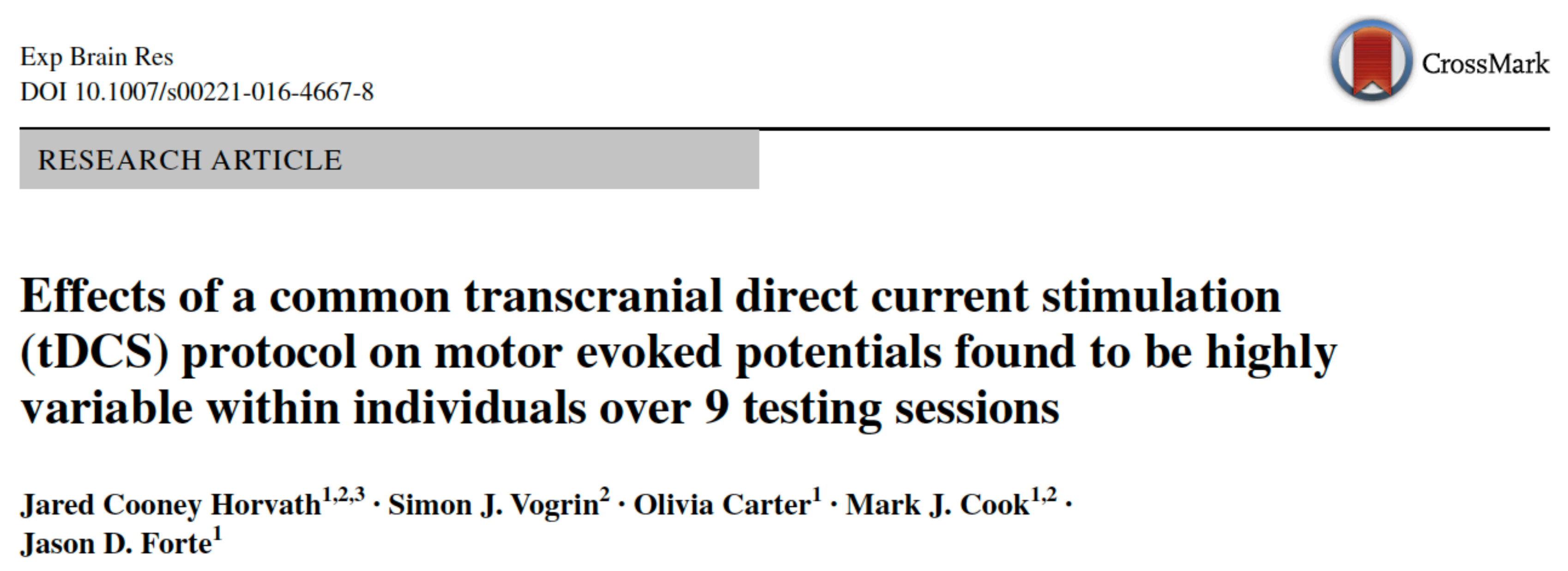


34th Annual International Conference of the IEEE EMBS
San Diego, California USA, 28 August - 1 September, 2012

A Pilot Study on Effects of 4x1 High-Definition tDCS on Motor Cortex Excitability

Egas M. Caparelli-Daquer[1], Trelawny J. Zimmermann[2], Eric Mooshagian[2], Lucas C. Parra[3], Justin K. Rice[3], Abhishek Datta[3], Marom Bikson[3], and Eric M. Wassermann[2]



Exp Brain Res
DOI 10.1007/s00221-016-4667-8

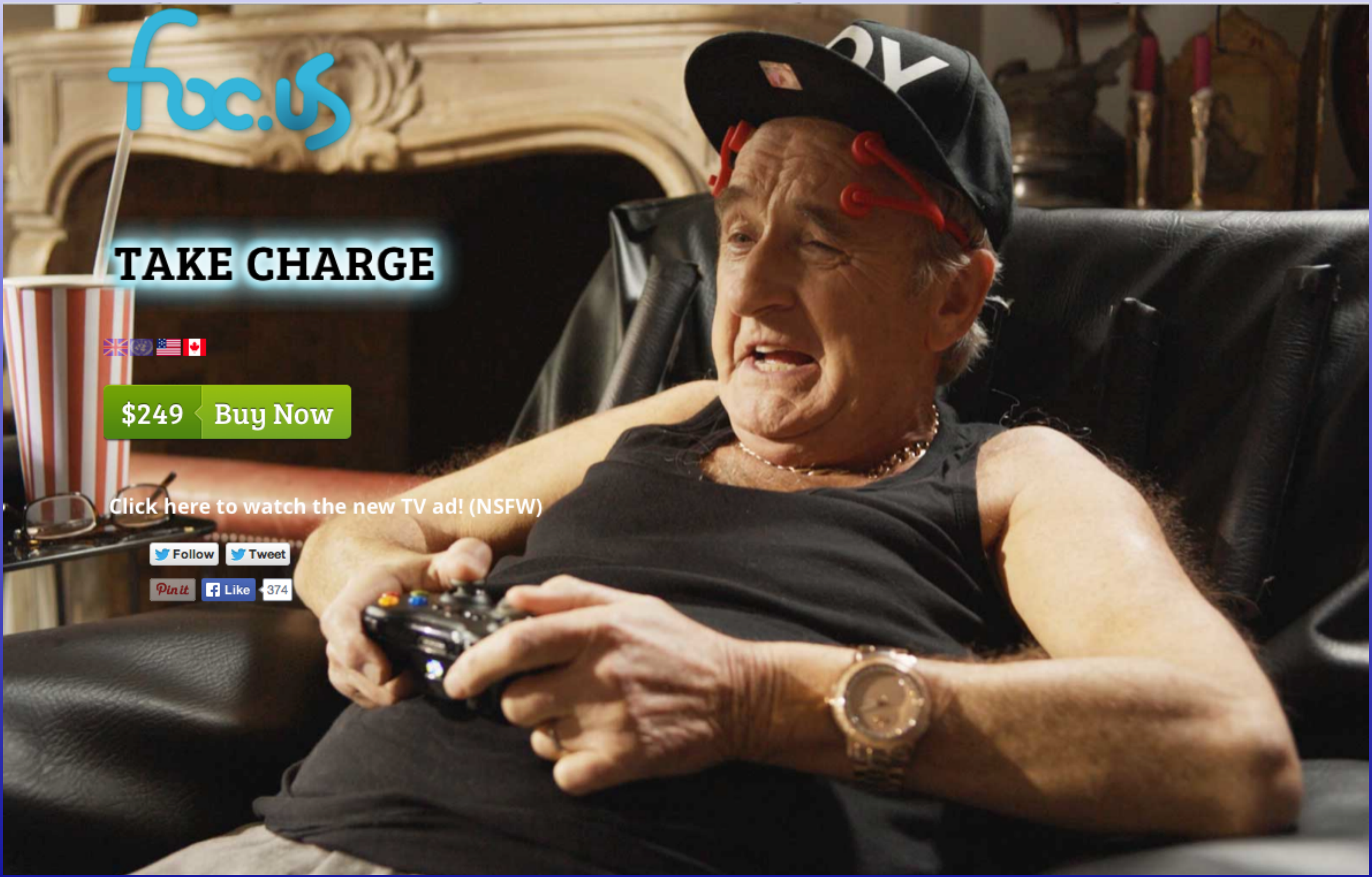
RESEARCH ARTICLE

Effects of a common transcranial direct current stimulation (tDCS) protocol on motor evoked potentials found to be highly variable within individuals over 9 testing sessions

Jared Cooney Horvath[1,2,3] · Simon J. Vogrin[2] · Olivia Carter[1] · Mark J. Cook[1,2] · Jason D. Forte[1]

TES improves…

ADHD
Alcoholism
Alzheimer disease
Amblyopia
Anorexia nervosa
Aphasia
Athletic performance
Autism
Bipolar disorder
Childhood dystonia
Chronic and acute pain
Cocaine dependence
Depression
Disorders of consciousness
Dystonia
Epilepsy
Essential tremor
Executive function
Fibromyalgia
Hemianopsia
Hemiparesis
Impulse control
Motor learning
Multiple sclerosis
Multiple sclerosis (spasticity)
Multitasking
Obesity
Parkinson disease
Post-polio syndrome
Schizophrenia
Smoking
TBI
Tinnitus



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