Transcranial magnetic stimulation(TMS)

Motor evoked potantials (MEP)

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Laboratory for Human and Experimental Neurophysiology (LAHEN)

School of Medicine, University of Split

Stimulation techniques – invasive
Deep brain stimulation (DBS)

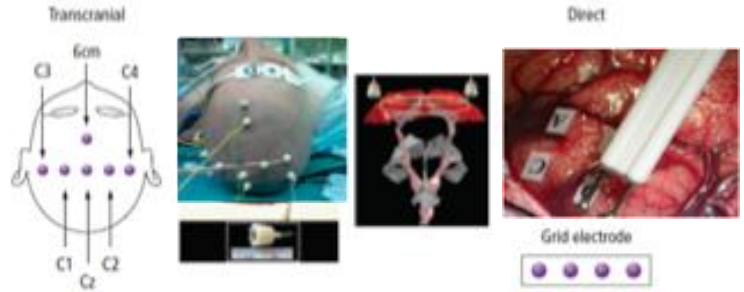
PARKINSON –DISEASE PATIENT- BEFORE IMPLANTATION

PARKINSON –DISEASE PATIENT- AFTER IMPLANTATION

Stimulation techniques – invasive Intraoperative neurophysiologic techniques in neurosurgery

TES (transcranial electric stimulation) i DCS (direct cortical stimulation)

STIMULACIJA



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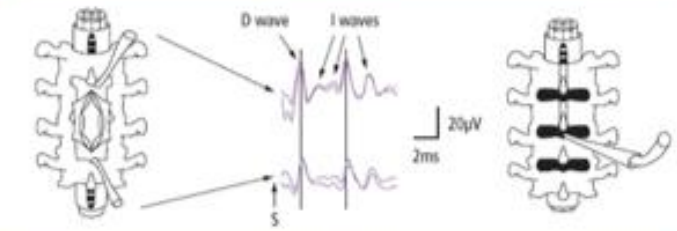

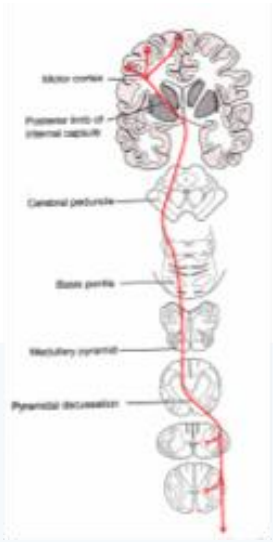

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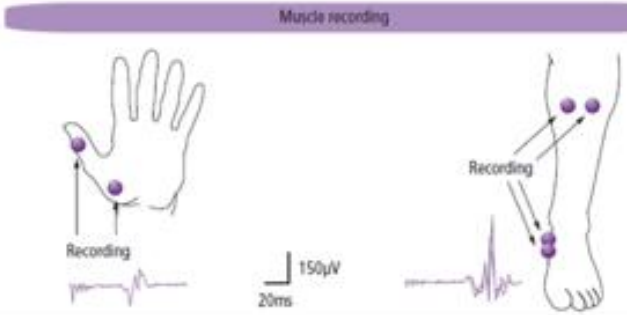
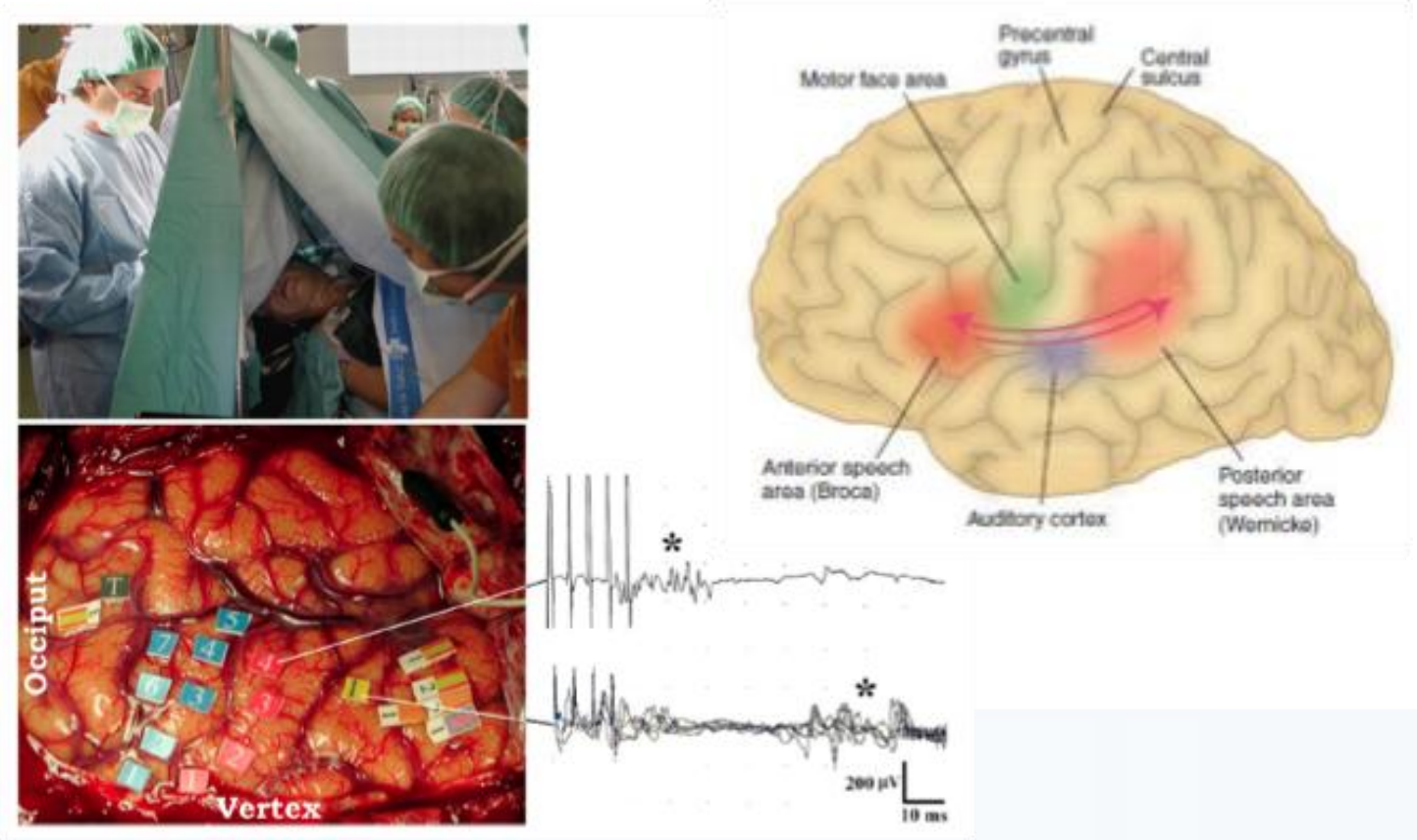


Stimulation techniques – invasive
Intraoperative neurophysiologic techniques in neurosurgery

DCS (direct cortical stimulation)



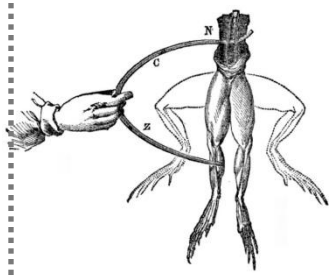
[Deletis V, Rogić M, Fernandez-Conejero I, Gabarros A, Jerončić. A Clinical Neurophysiology 2014]

Short historical overview…

1. st. b.n.e.

Galen i Scribonius Largus u Rimu

Earliest stimulation "devices" were animals. Electric stingray and eel to treat headaches and other ailments.



1791.

Luigi Galvani

The discovery of electricity - electric pulses drives the nervous system

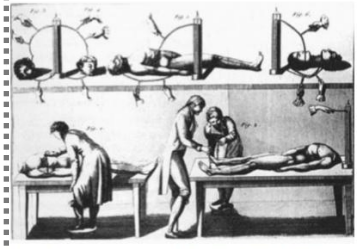
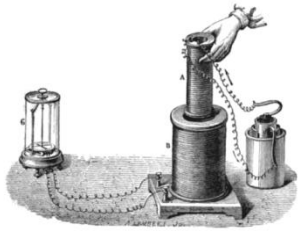


Figure 2.6 Copper plate from Giovanni Aldini (1804) showing electrical stimulation experiments performed on human bodies following decapitation.

1804.

Giovanni Aldini

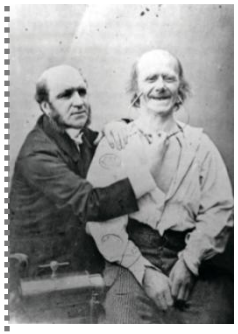
Experiments with electric "therapy" for the treatment of psychosis and melancholy, as well as "electrical resuscitation"



1831.

Michael Faraday

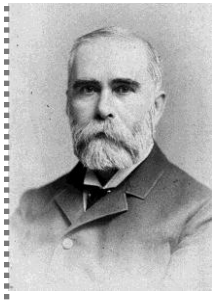
The discovery of electromagnetic induction principle on which are based all the neurophysiological effects of magnetic stimulation



1850.

Guillaume Duchenne de Boulogne

First used an electric current for diagnostic and therapeutic purposes, "faradizing" - an early form of tDCS

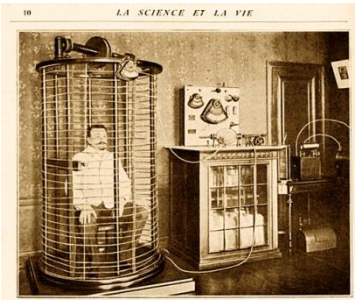


1874.

Robert Bartholow

The first recorded simulation of the human brain to the patient

Short historical overview…



1896.

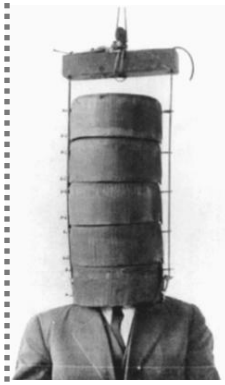
Arsene d'Arsonval

The first noticed inducing magnet phosphene using magnetic fields

1910.

Silvanus Philips Thompson

AC replaced DC source.
The device for inducing a magnetic phosphene.



1911.

Magnusson i Stevens

Coils to treat headaches

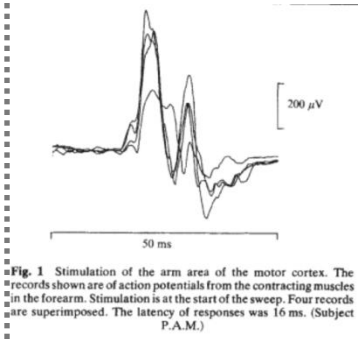
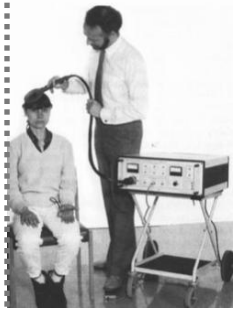


Fig. 1 Stimulation of the arm area of the motor cortex. The records shown are of action potentials from the contracting muscles in the forearm. Stimulation is at the start of the sweep. Four records are superimposed. The latency of responses was 16 ms. (Subject P.A.M.)

1980.

Merton & Morton

Demonstrated ability of depolarization of neurons (MEP - Motor Evoked Potentials) with Transcranial DC current



1985.

Anthony Barker, University of Sheffield, UK

The first magnetic stimulation of the brain - the birth of modern transcranial magnetic stimulation (TMS)

2016. -

Moderni uređaj za transkranijalnu magnetsku stimulaciju

SOMATIC MOTOR AND SENSORY REPRESENTATION IN THE CEREBRAL CORTEX OF MAN AS STUDIED BY ELECTRICAL STIMULATION.[1]

BY WILDER PENFIELD AND EDWIN BOLDREY (MONTREAL).

(1) Introduction.

Recent experimental work on the localization of motor function in the cerebral cortex has spurred us to make a complete analysis of the records of our patients (163 in all) upon each of whom we have carried out electrical exploration of the cortex under local anæsthesia.

[1] From the Montreal Neurological Institute and the Department of Neurology and Neurosurgery of McGill University, Montreal. Read before the American Neurological

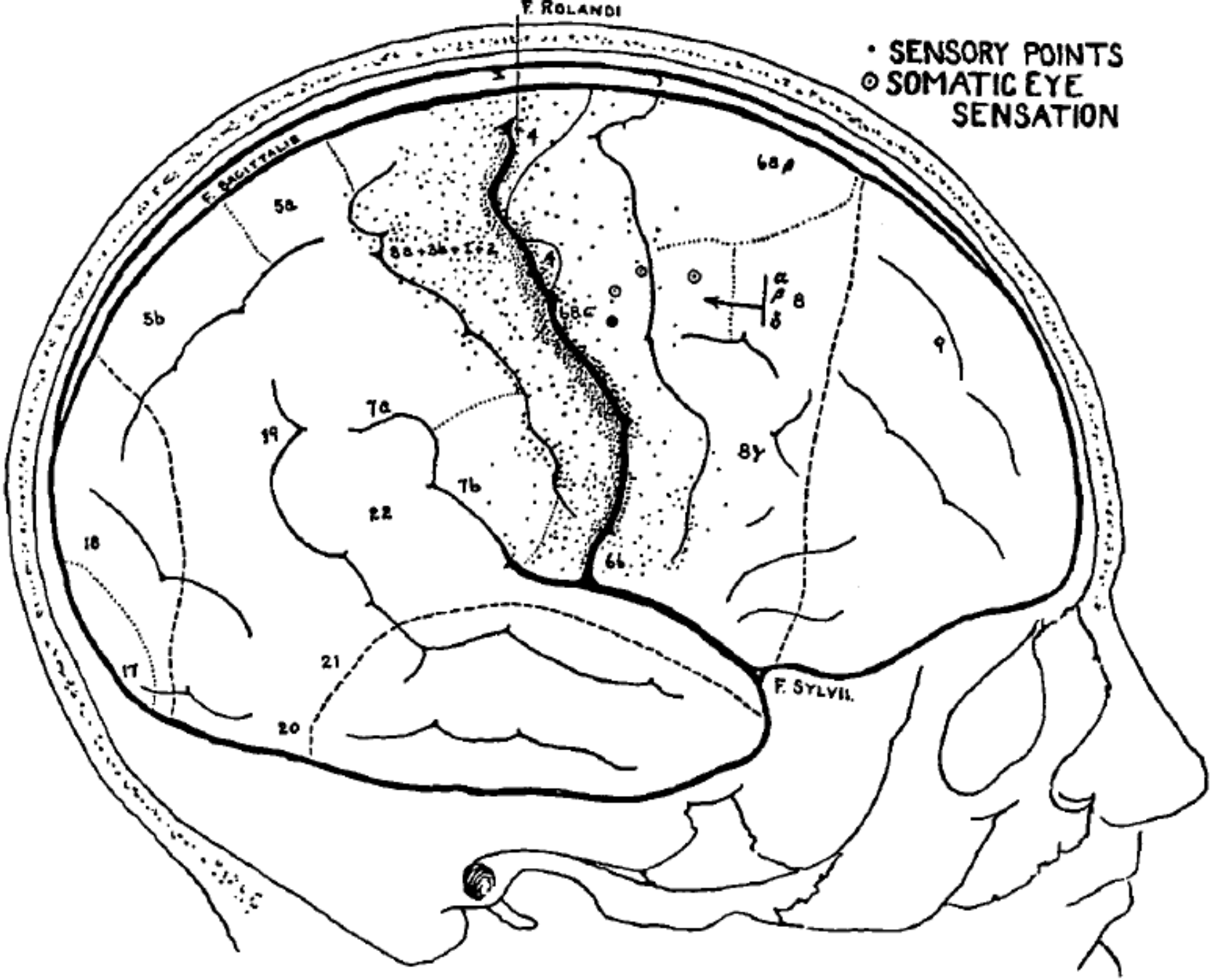


FIG. 30—Sensory cortex. Black dots represent actual sensory responses in some part of the body. ⊙ = sensation in the eyes.

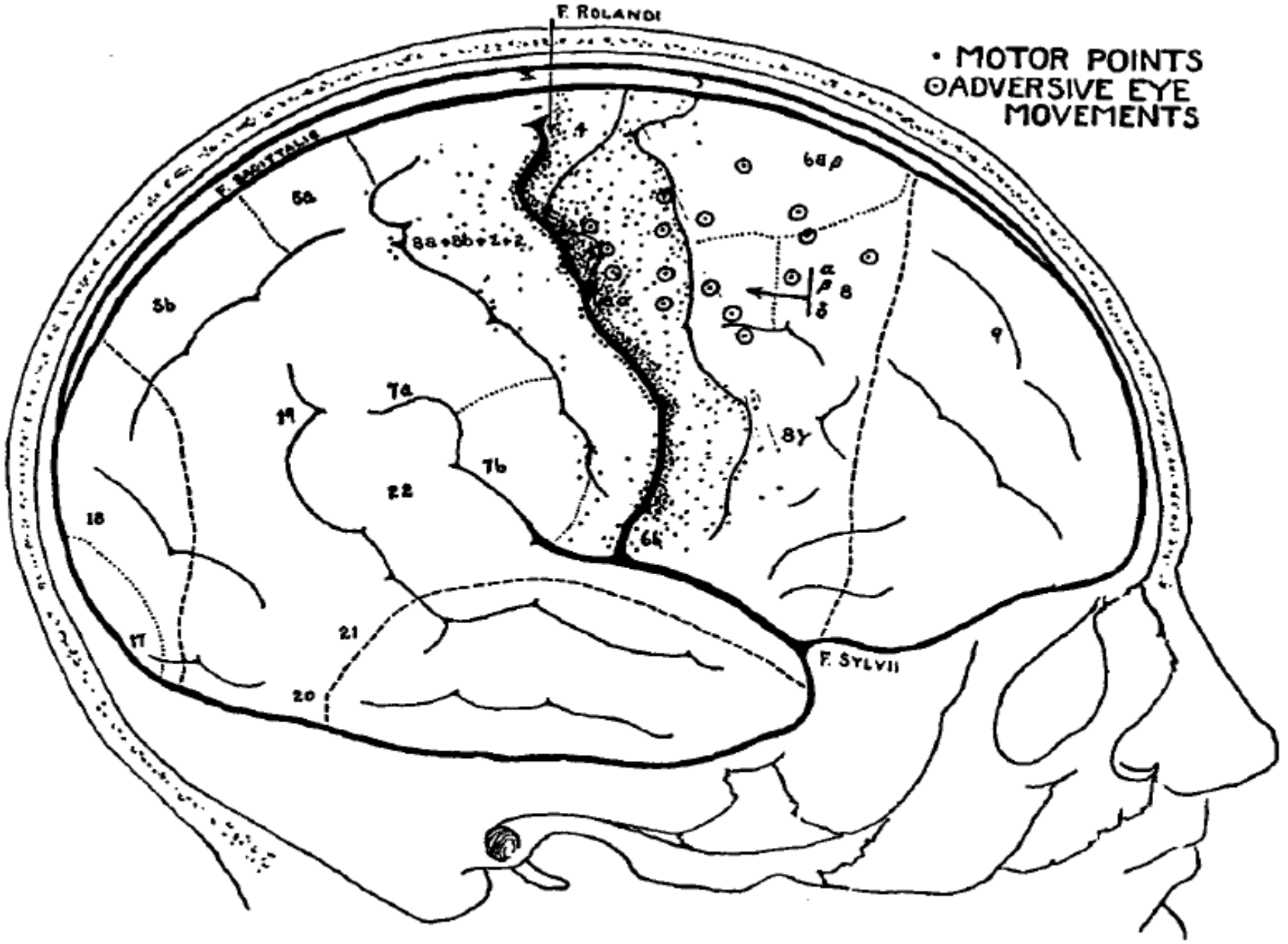
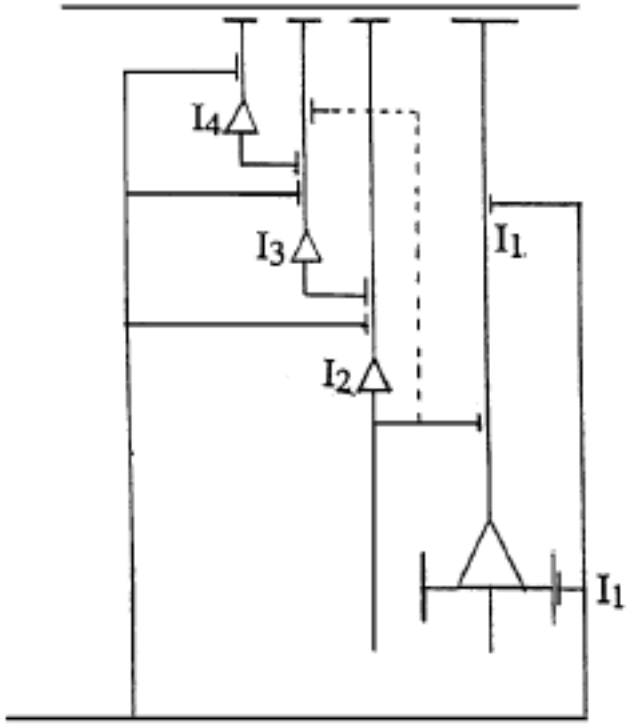


FIG. 29.—Motor cortex. Each black dot represents an actual motor response. The number 4 indicates where Area 4 extends from the anterior wall of the fissure on to the surface, according to Vogt. The remainder of the outer surface of the precentral gyrus is made up of Area 6*a alpha*. ⊙ = conjugate movements of eyes to the opposite side or upward.

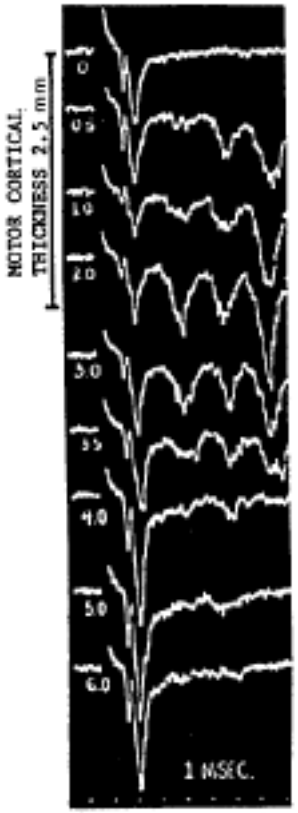
SINGLE- AND MULTIPLE-UNIT ANALYSIS OF CORTICAL STAGE OF PYRAMIDAL TRACT ACTIVATION*

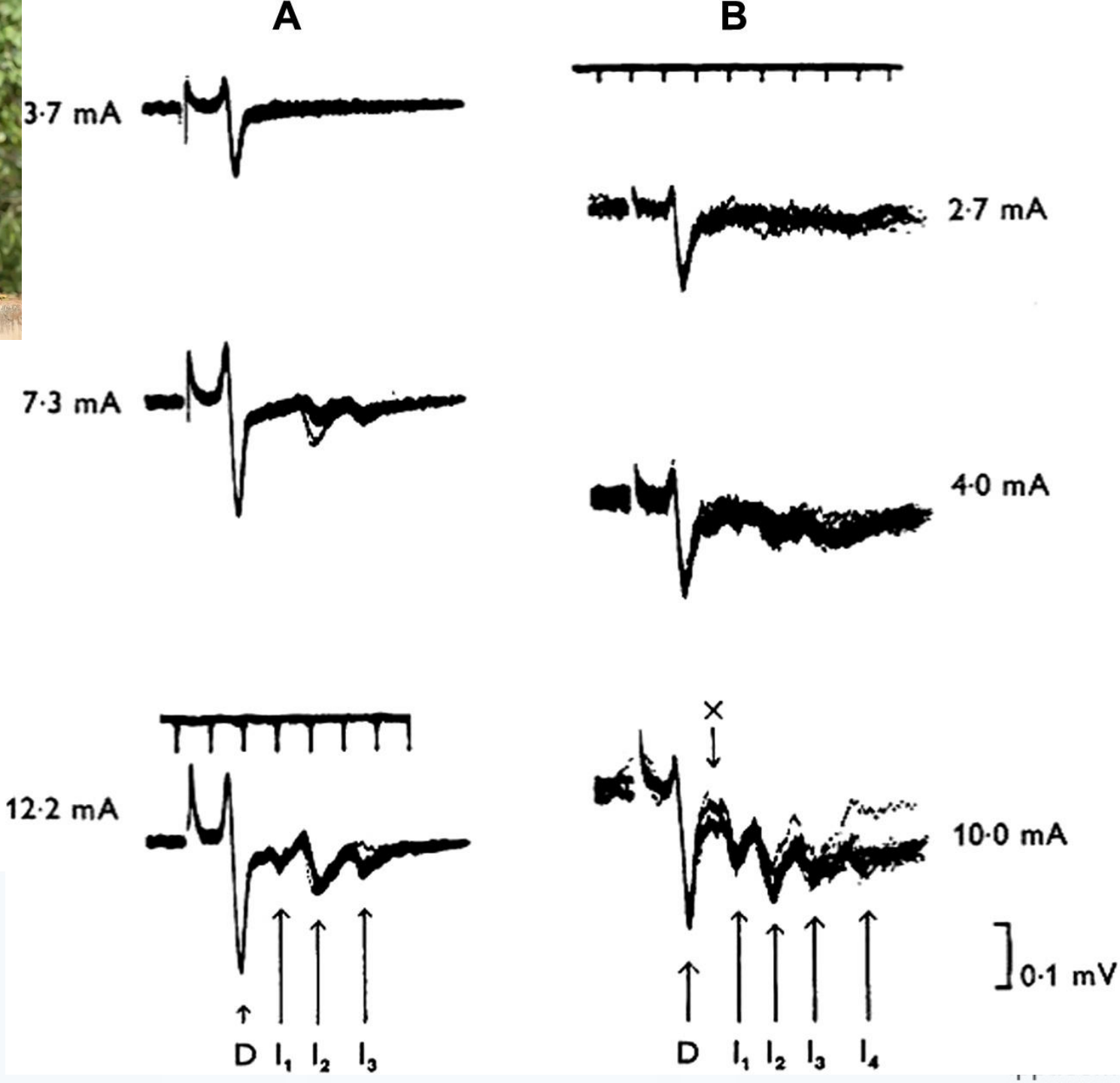
HARRY D. PATTON AND VAHÉ E. AMASSIAN†
Department of Physiology and Biophysics, University of Washington School of Medicine, Seattle 5, Washington

(Received for publication October 26, 1953)



corticocortical fiber




A
B
3·7 mA
2·7 mA
7·3 mA
4·0 mA
12·2 mA
10·0 mA
0·1 mV
D
I1
I2
I3
I4

Stimulation of the cerebral cortex in the intact human subject

P. A. Merton & H. B. Morton

The National Hospital, Queen Square, London WC1N 3BG, UK

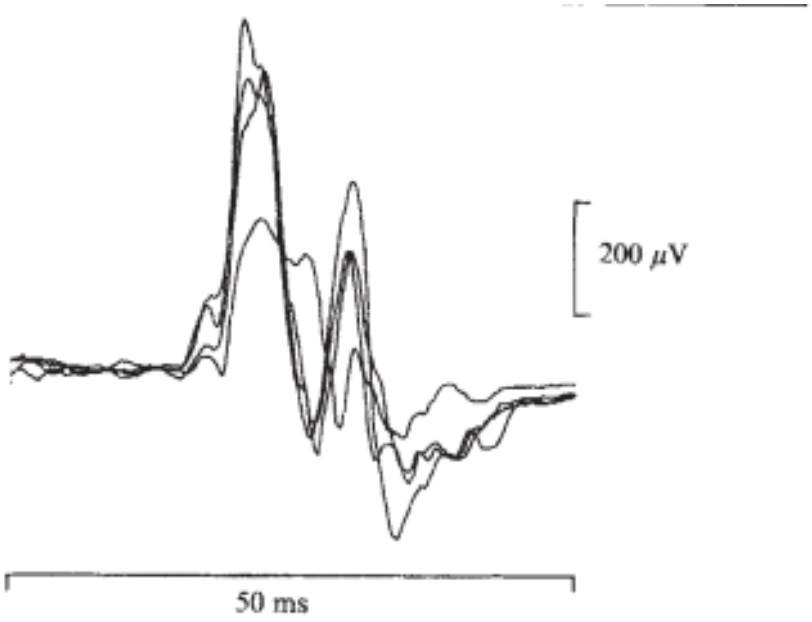
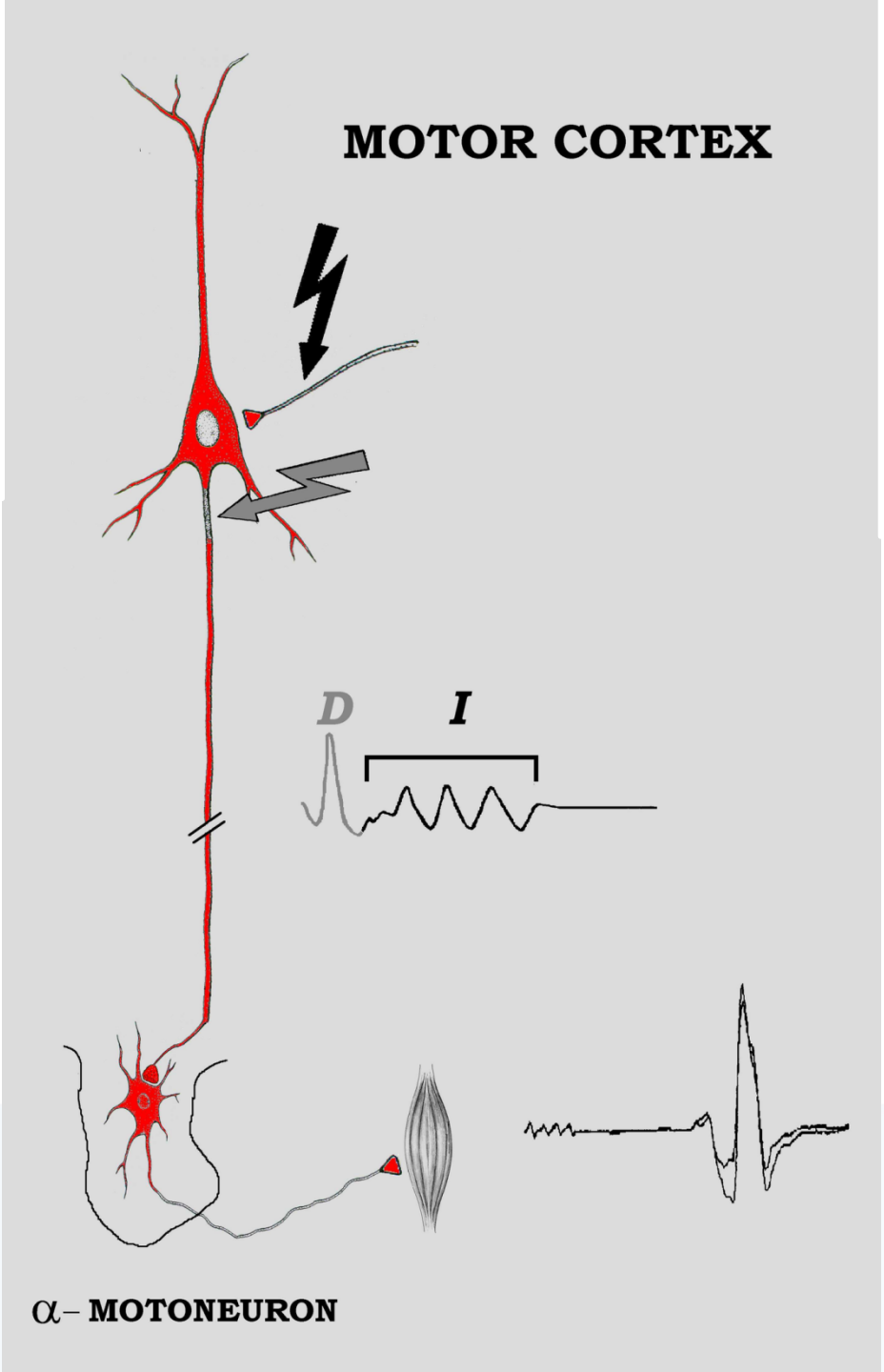


Fig. 1 Stimulation of the arm area of the motor cortex. The records shown are of action potentials from the contracting muscles in the forearm. Stimulation is at the start of the sweep. Four records are superimposed. The latency of responses was 16 ms. (Subject P.A.M.)

Motor evoked potantials recorded from hand muscle - MEP -

Nature Vol. 285 22 May 1980



Principles of MEP Interpretation

D-wave	Muscle MEP	Motor Status
unchanged	preserved	unchanged
unchanged	lost uni-or bilaterally	temporary motor deficit
30-50 % decrease	preserved	unchanged
30-50 % decrease	lost uni-or bilaterally	temporary motor deficit
>50 % decrease	lost bilaterally	long term motor deficit

THE LANCET

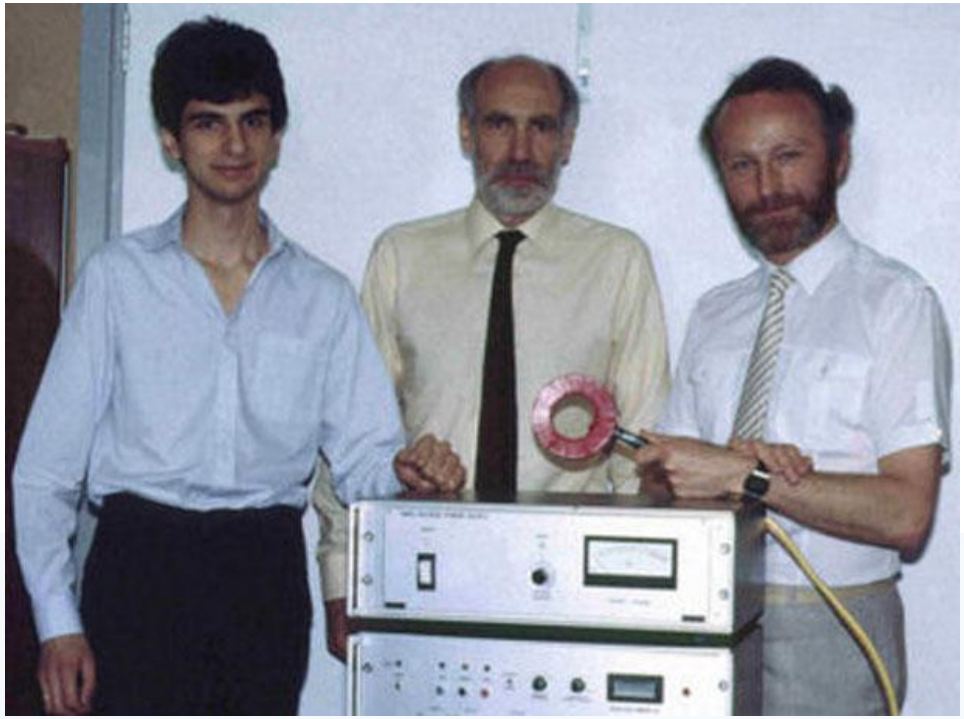
Volume 325, Issue 8437, 11 May 1985, Pages 1106–1107

Originally published as Volume 1, Issue 8437

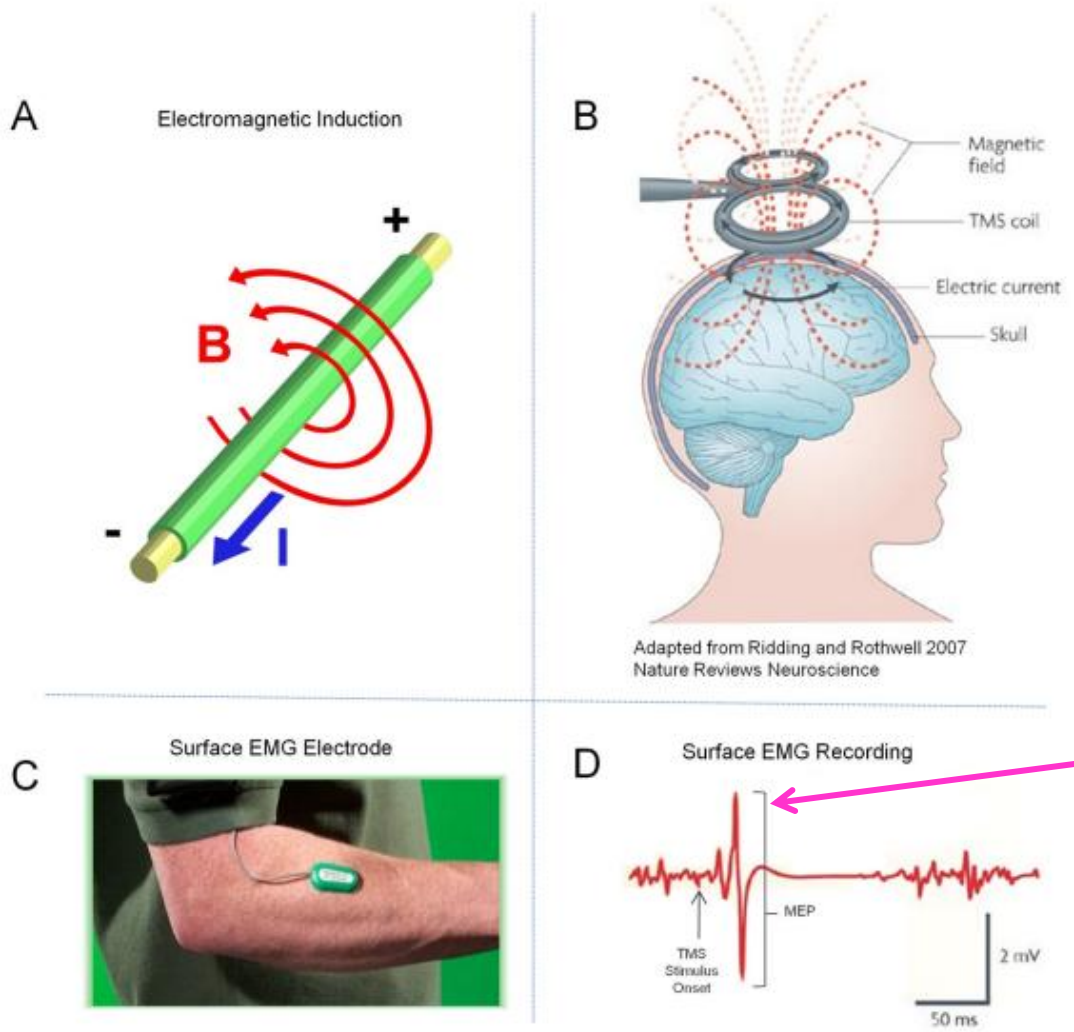
Letters to the Editor

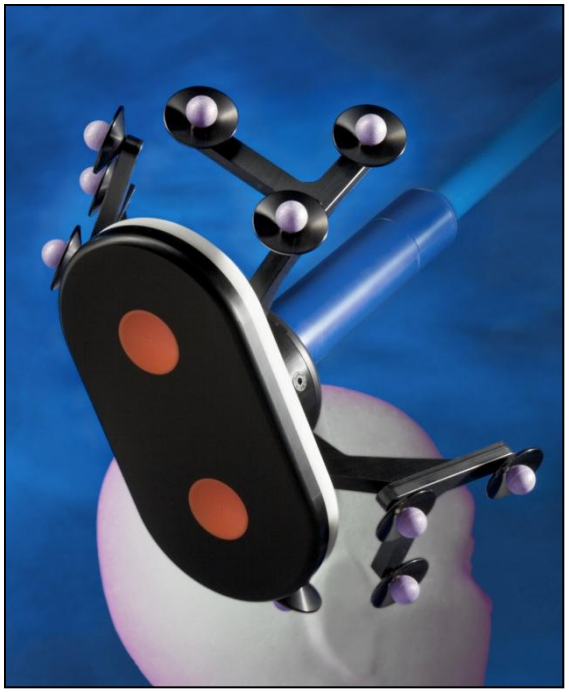
NON-INVASIVE MAGNETIC STIMULATION OF HUMAN MOTOR CORTEX

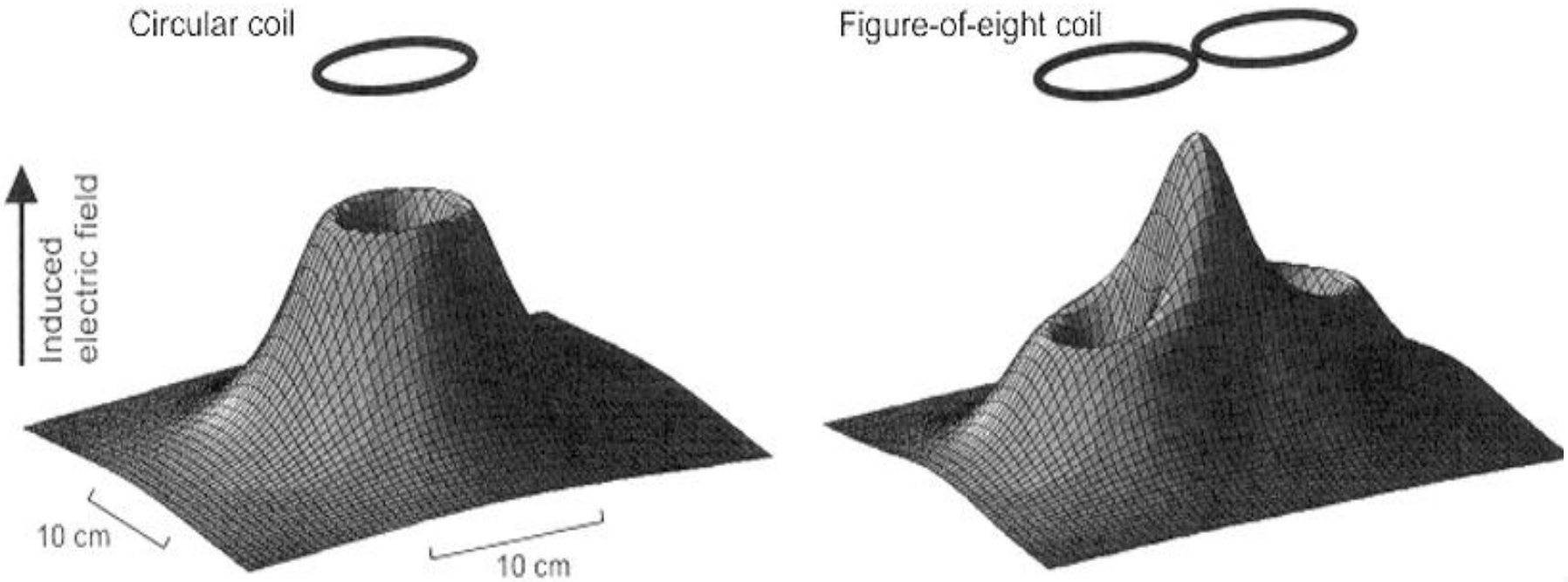
A.T. Barker[a], R. Jalinous[a], I.L. Freeston[b]



Transcranial magnetic stimulation (TMS)







RJ Ilmoniemi, J Ruohonen. *Crit. Rev. Biomed. Eng.,* 1999

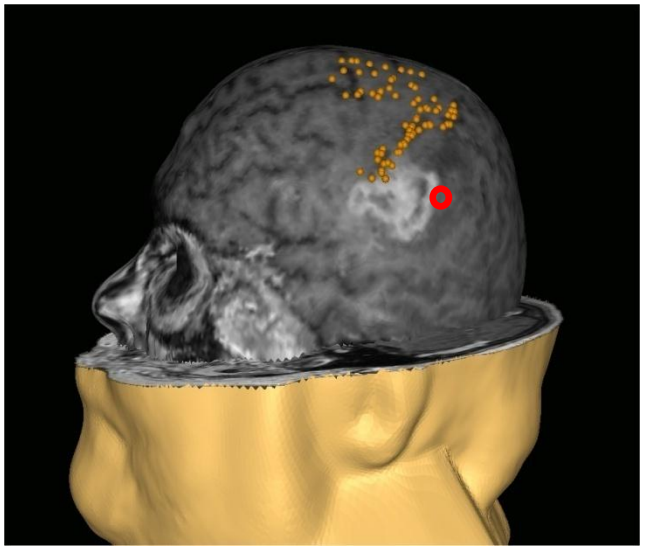
SAFETY of TMS – Contraindications

- Pacemakers and other electronic implants are contraindication to TMS
- Patients with a history of epilectic seizures have higher risk of TMS-induced seizures
- For complete list, consult the Operator's guide

- Physical force on metal objects within 20 cm of the coil
- It is not possible to directly affect the human heart (limited discharge energy, distance, fast pulse rise time of the magnetic field waveform)

CRITICAL IN NEUROSURGERY

- **Avoiding areas that are crucial in everyday life**
  - Motor areas
  - Sensory areas
  - Language areas

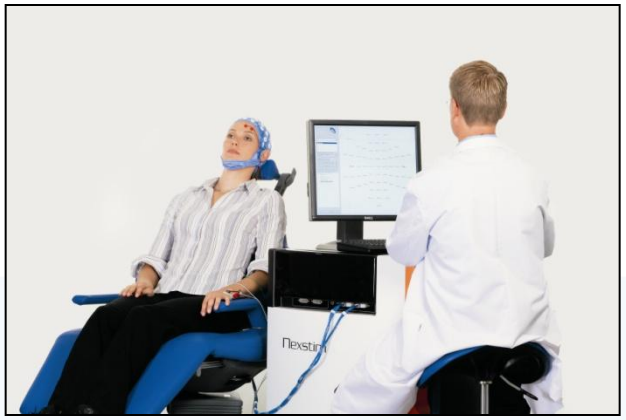


- **Getting results fast**
  - Part of clinical workflow

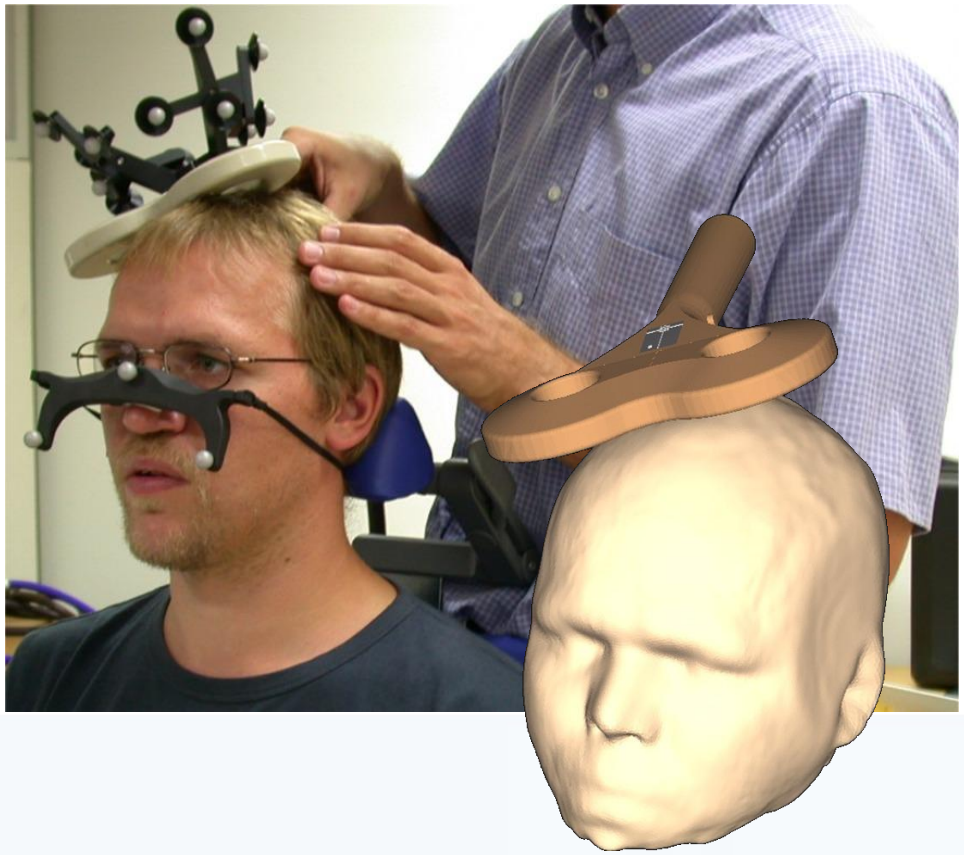
- **Getting the same views prior to operation and during surgery**

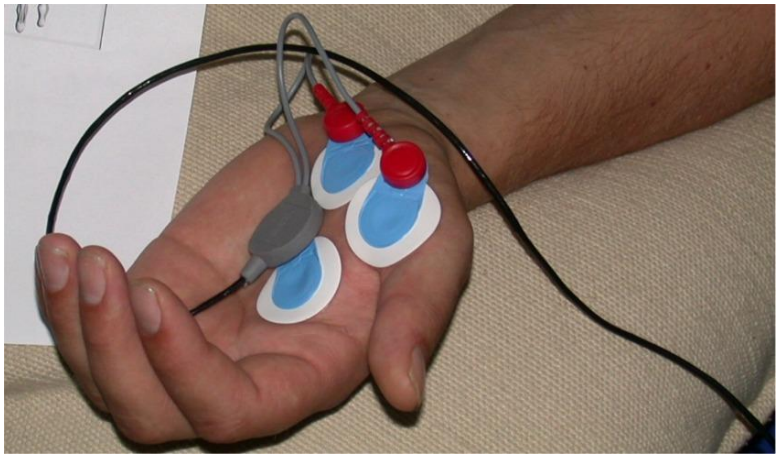
Responses to TMS

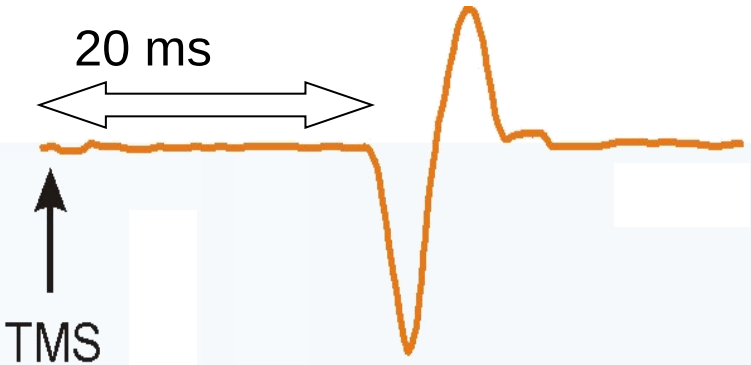
- Behavioral
- EMG, electromyography
- EEG, electroencephalography

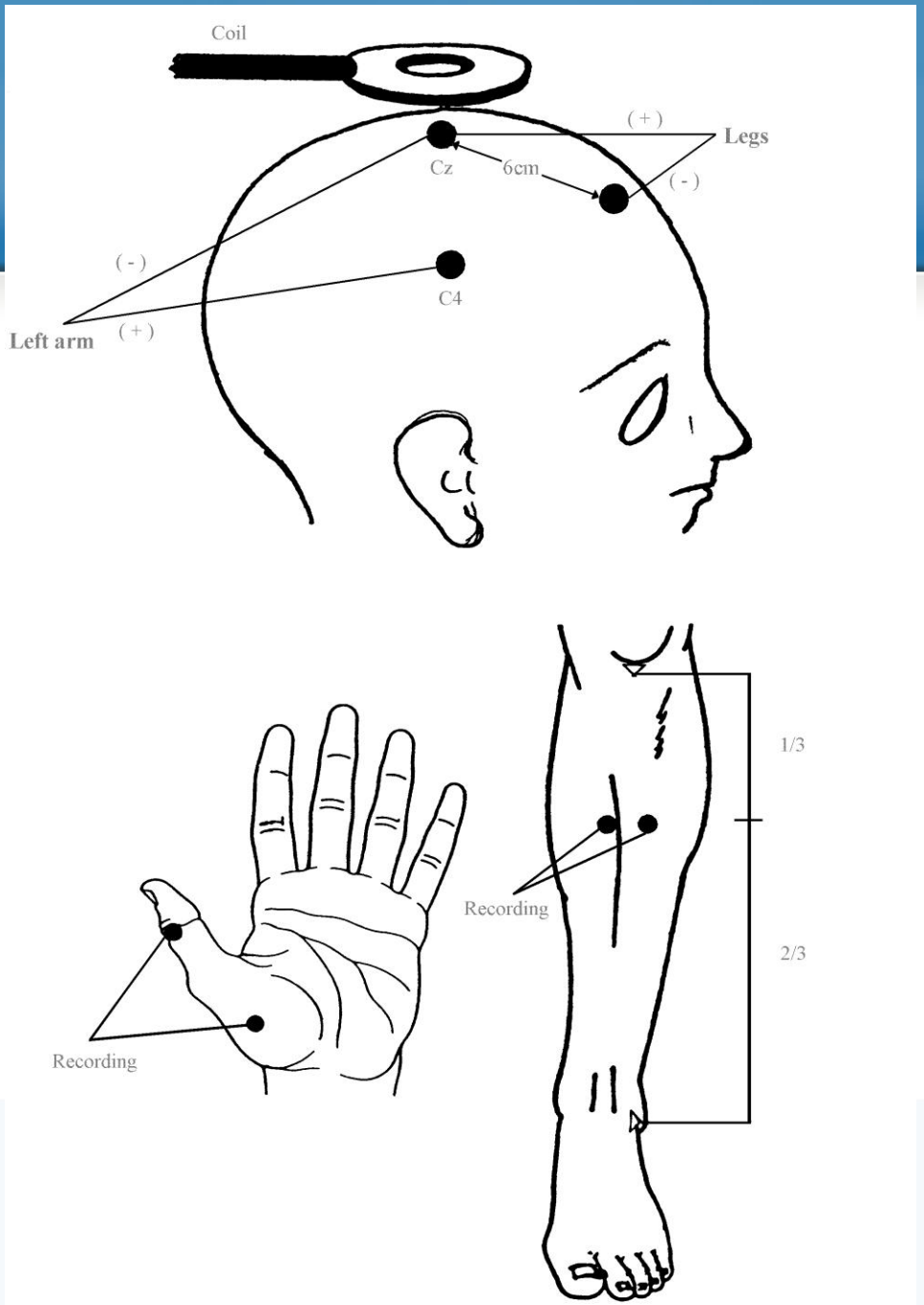


MEP – motor evoked potential

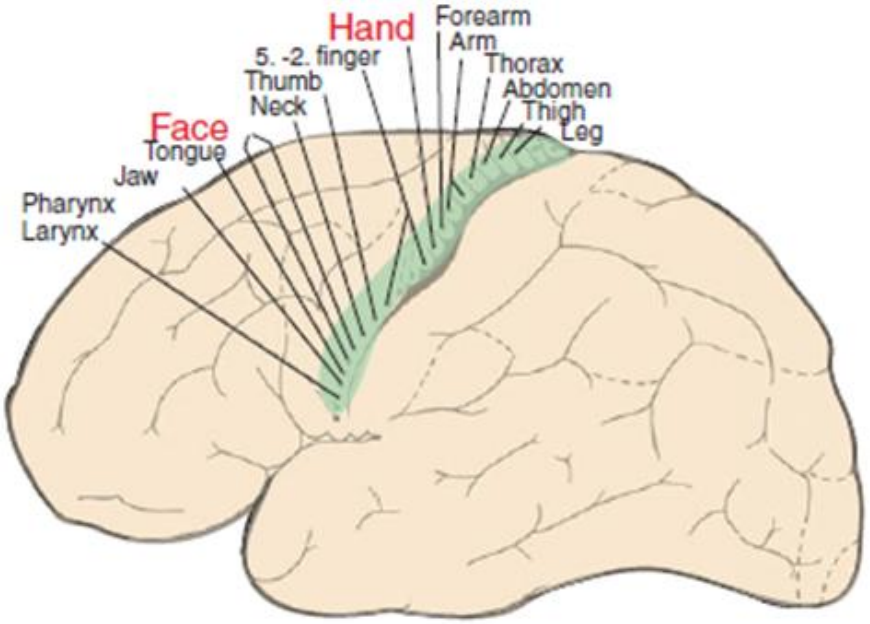


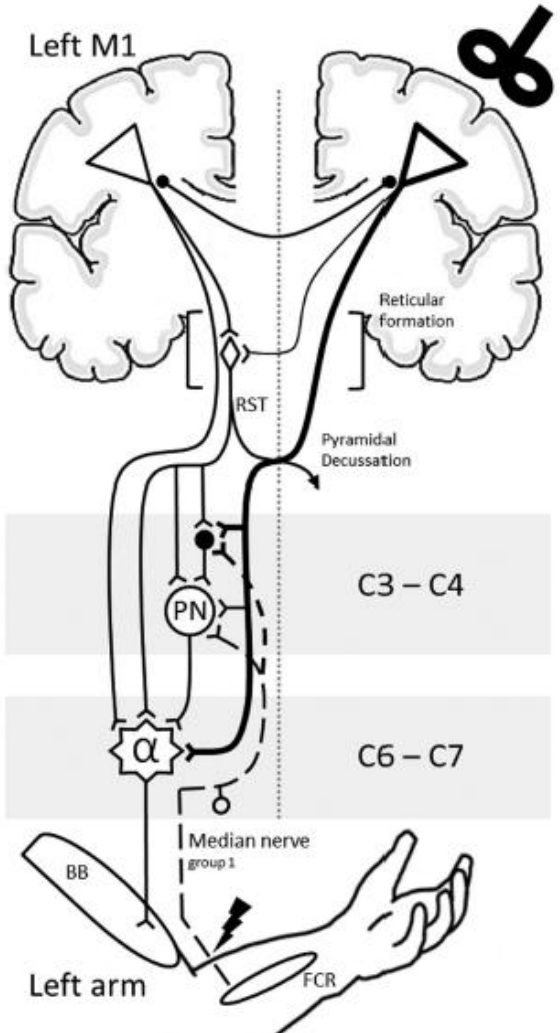






MEP – motor evoked potential





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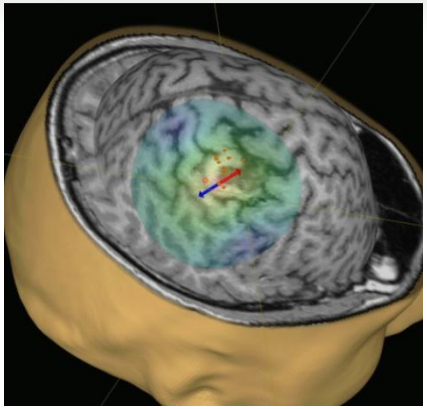
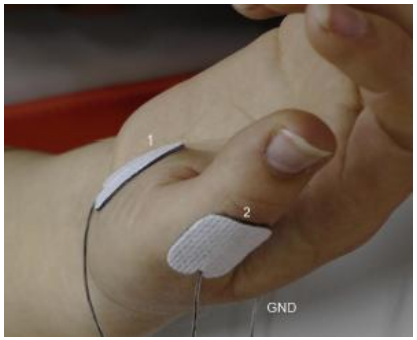
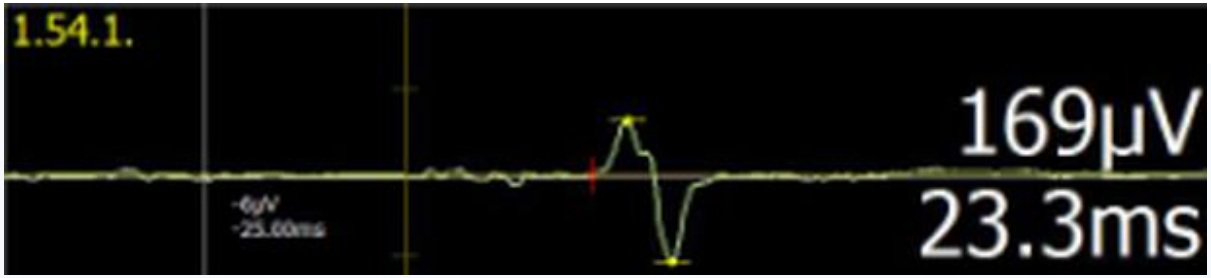




Standard in preoperative neurosurgical mapping of patients



Case report

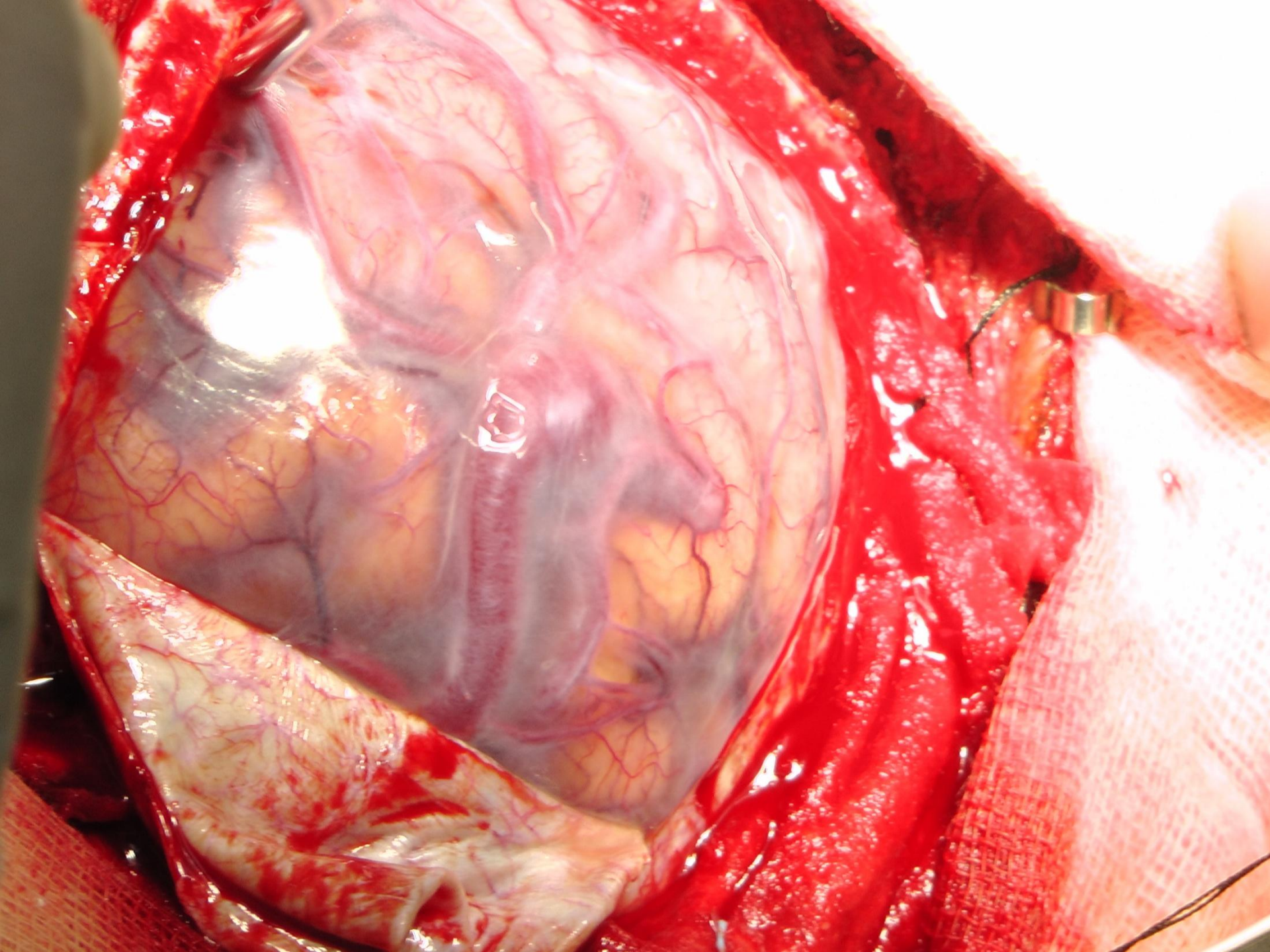
1973., left handed

AVM reg. frontalis lat. dex

location of AVM near precentral gyrus which controls the hand

fMRI + paradigme of contraction of the left hand to detect relation of AVM and primary motor cortex for hand representation

the tract of the right corticospinal tract close to the edges of vascular malformation – medioposterior edge of the AVM



Clinical Neurophysiology 123 (2012) 2205–2211

Contents lists available at SciVerse ScienceDirect

Clinical Neurophysiology

journal homepage: www.elsevier.com/locate/clinph

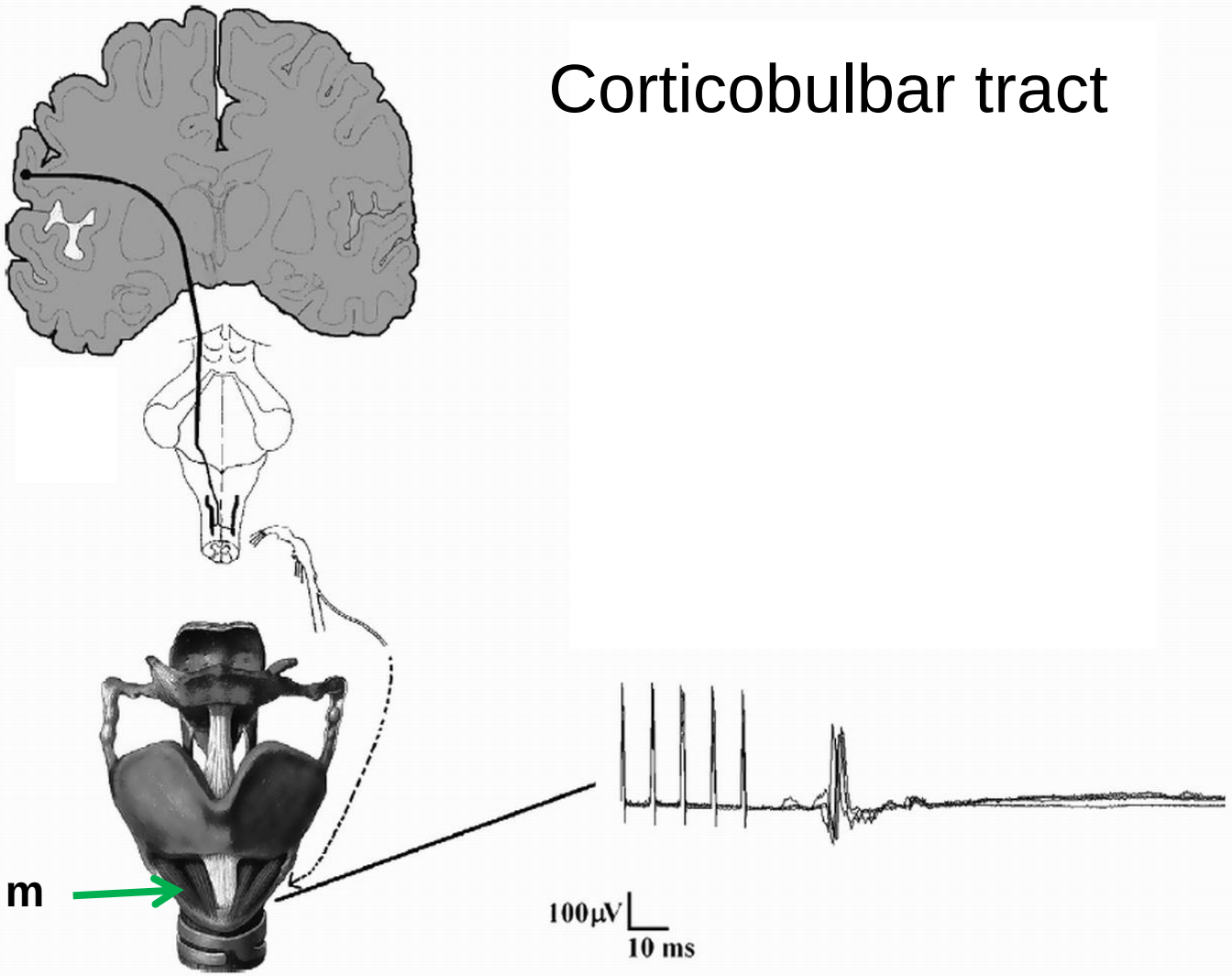
Representation of cricothyroid muscles at the primary motor cortex (M1) in healthy subjects, mapped by navigated transcranial magnetic stimulation (nTMS)

Josep Espadaler [a,1], Maja Rogić [b,1], Vedran Deletis [b,*,1], Alba Leon [a,1], Cesar Quijada [a], Gerardo Conesa [c]

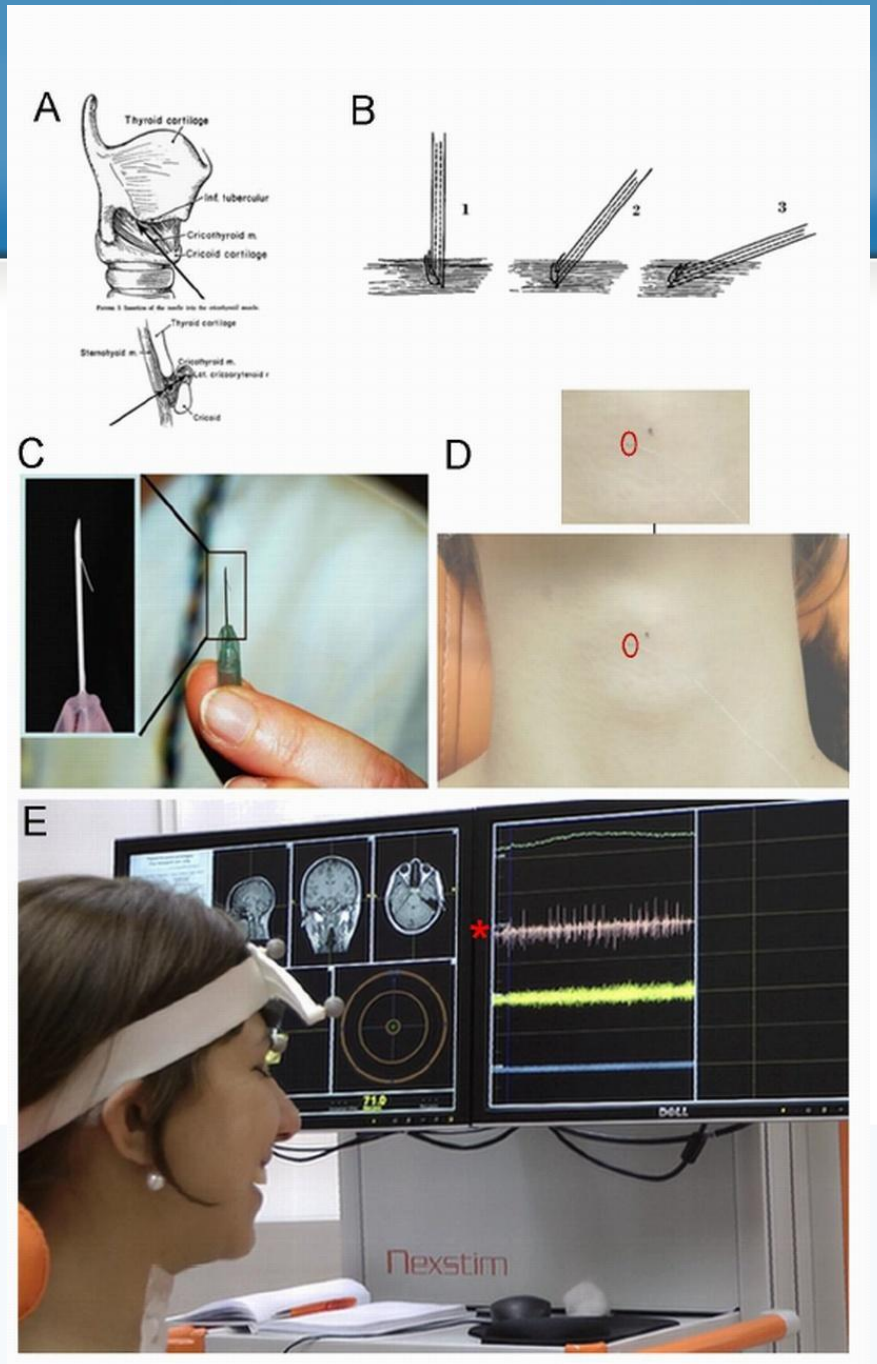
[a] Department of Clinical Neurophysiology, Hospital Del Mar, Barcelona, Spain
[b] Laboratory for Human and Experimental Neurophysiology (LAHEN), School of Medicine, University of Split, Split, Croatia
[c] Department of Neurosurgery, Hospital Del Mar, Barcelona, Spain

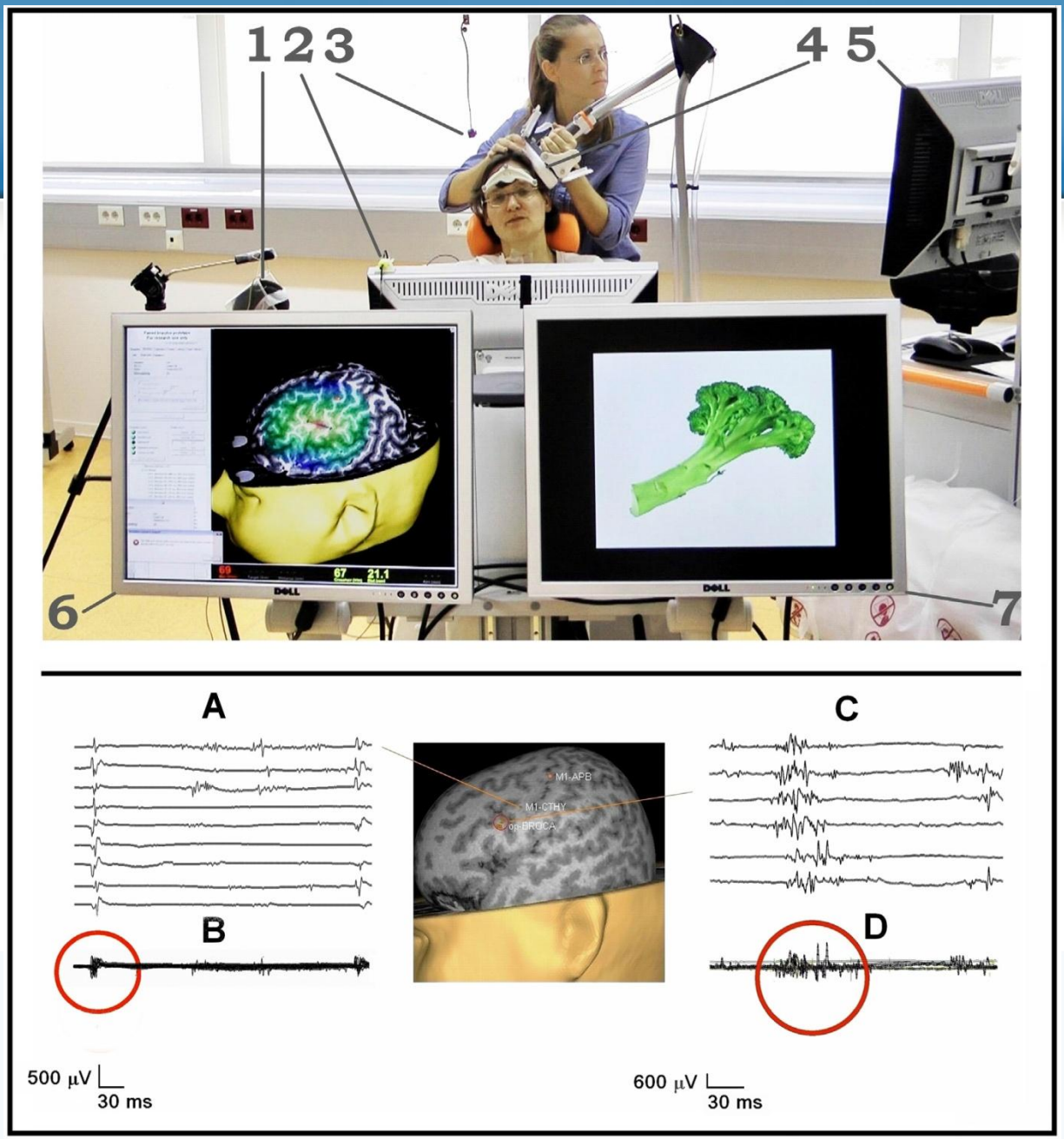
V. Deletis et al./Clinical Neurophysiology 122 (2011) 1883–1889

Corticobulbar tract

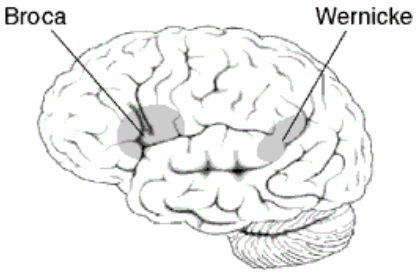


Crocotyroid m


A
Thyroid cartilage
Inf. tuberculur
Cricothyroid m.
Cricoid cartilage
Thyroid cartilage
Sternohyoid m.
Cricothyroid m.
Cricoid
B
1
2
3
C
D
0
0
E
Nexstim



Inducing transient language disruptions by mapping of Broca's area with modified patterned repetitive transcranial magnetic stimulation protocol



Clinical article

Maja Rogić, M.Sc., Ph.D.,[1] Vedran Deletis, M.D., Ph.D.,[1,2] and Isabel Fernández-Conejero, M.D.[3]

[1]Laboratory for Human and Experimental Neurophysiology, School of Medicine, University of Split, Croatia; [2]Department for Intraoperative Neurophysiology, Roosevelt Hospital, New York, New York; and [3]Intraoperative Neurophysiology Unit, University Hospital Bellvitge, Barcelona, Spain

Object. Until now there has been no reliable stimulation protocol for inducing transient language disruptions while mapping Broca's area. Despite the promising data of only a few studies in which speech arrest and language disturbances have been induced, certain concerns have been raised. The purpose of this study was to map Broca's area by using event-related navigated transcranial magnetic stimulation (nTMS) to generate a modified patterned nTMS protocol.

Methods. Eleven right-handed subjects underwent nTMS to Broca's area while engaged in a visual object-naming task. Navigated TMS was triggered 300 msec after picture presentation. The modified patterned nTMS protocol consists of 4 stimuli with an interstimulus interval of 6 msec; 8 or 16 of those bursts were repeated with a burst repetition rate of 12 Hz. Prior to mapping of Broca's area, the primary motor cortices (M1) for hand and laryngeal muscles were mapped. The Euclidian distance on MRI was measured between cortical points eliciting transient language disruptions and M1 for the laryngeal muscle.

Results. On stimulating Broca's area, transient language disruptions were induced in all subjects. The mean Euclidian distance between cortical spots inducing transient language disruptions and M1 for the laryngeal muscle was 17.23 ± 4.73 mm.

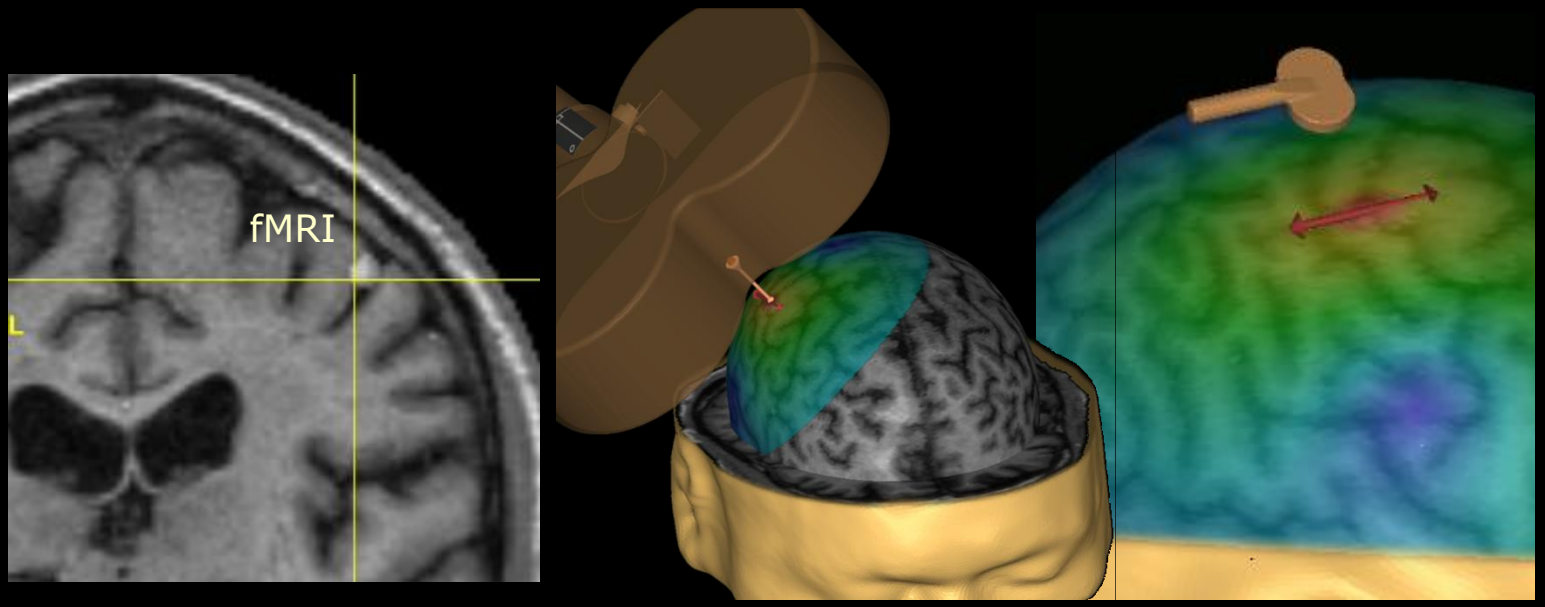
Conclusions. The stimulation paradigm with the modified patterned nTMS protocol was shown to be promising and might gain more widespread use in speech localization in clinical and research applications.

J Neurosurg / January 3, 2014

TMS terapijski učinci

(depresija, bol)

Patient with Brachial plexus lesion: fMRI-guided and NBS-targeted rTMS evoked phantom sensations and pain relief.



Courtesy of Prof. J-P Lefaucheur.
Hôpital Henri Mondor, Creteil, France