Plasticitat Cerebral i noves teràpies

Estimulació Cerebral No Invasiva

José Mª Tormos
CITSAM – Universidad Católica de Valencia
Responsable programa Salud Cerebral

https://www.dropbox.com/sh/za41ai4filopr41/AADMDhFcLNsuG3Lrbgm5h2bWa?dl=0

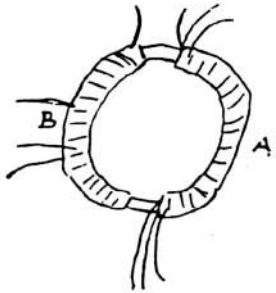
Estimulación Magnética Transcraneal

Michael Faraday, 1836

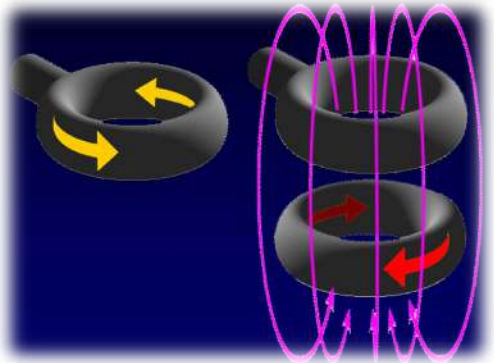
Sylvanus P. Thompson, 1910

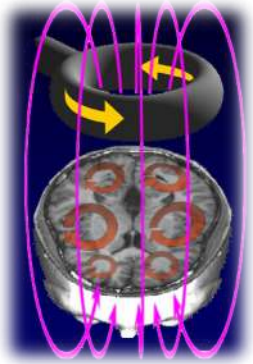
Magnusson y Stevens, 1911

Anthony T. Barker, 1984

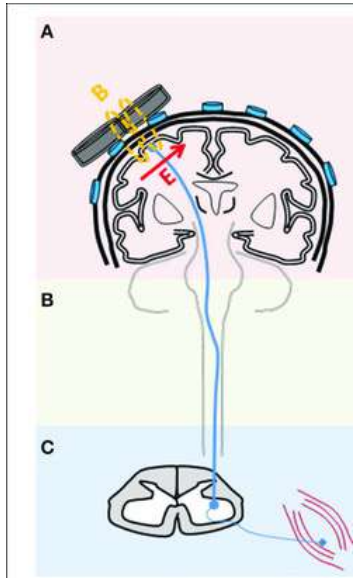


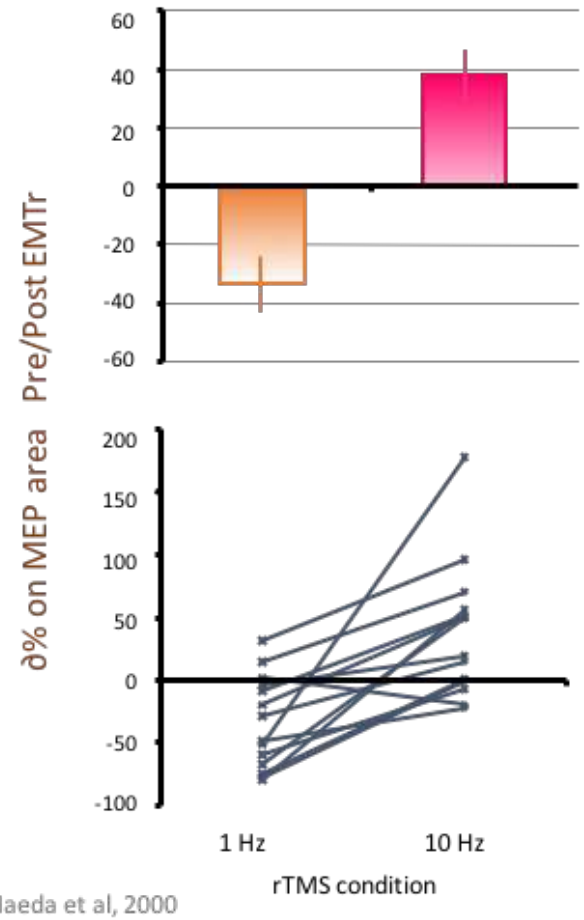
Un campo magnético que cambia en el tiempo puede inducir una corriente eléctrica en un conductor cercano.



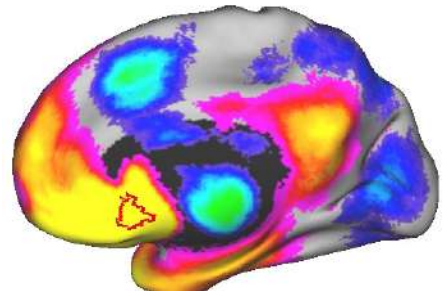


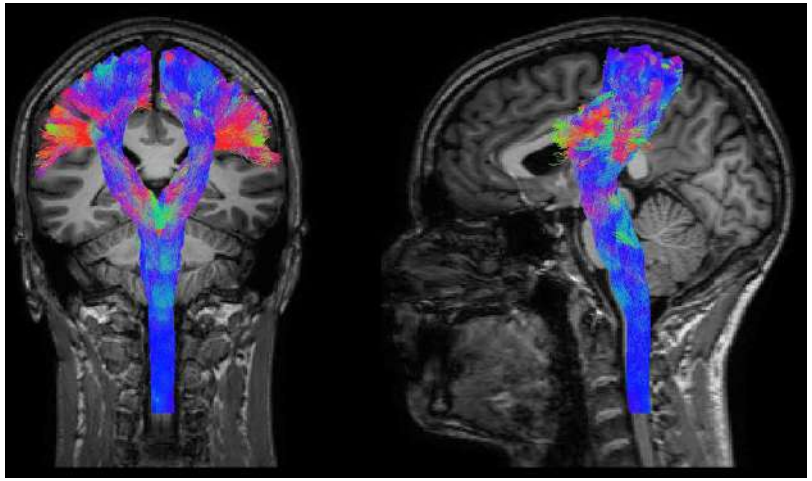
Estimulación Magnética Transcraneal





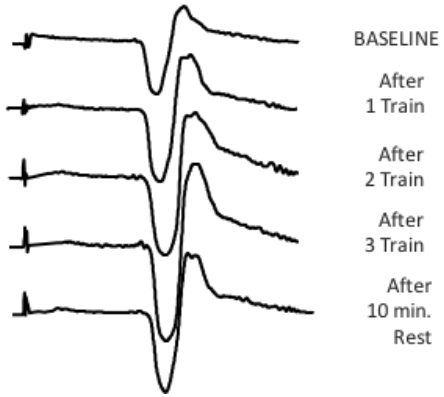
Maeda et al, 2000

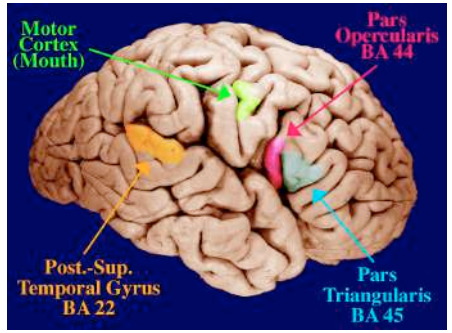




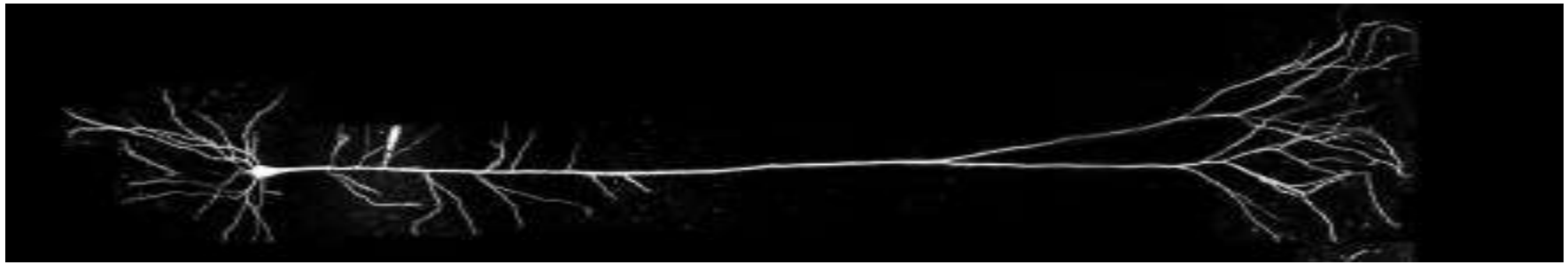
Efecto de los trenes de EMTr sobre la amplitud de los PEM en el PID

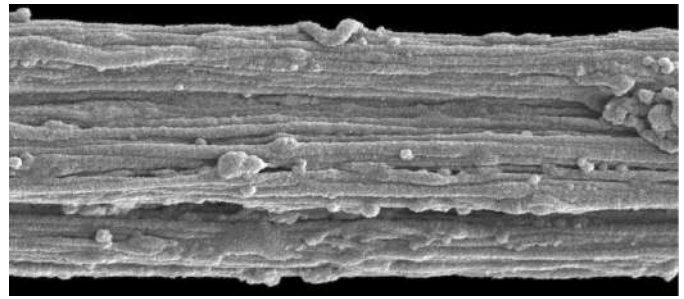
(10 Hz, 90% Motor Thresholds, 10 s, 5 min inter-train interval)

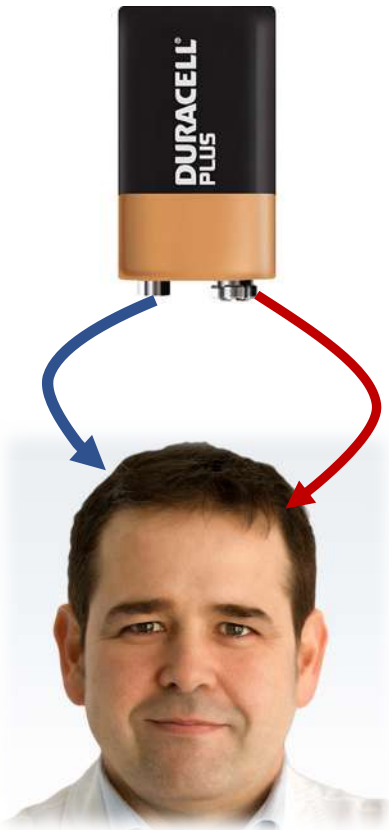


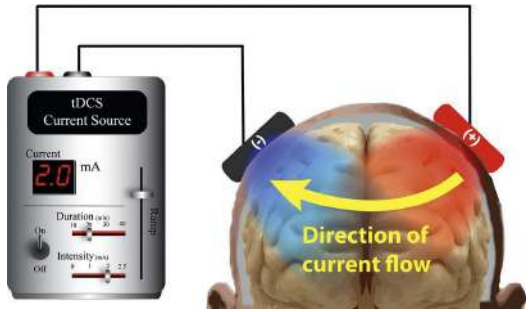


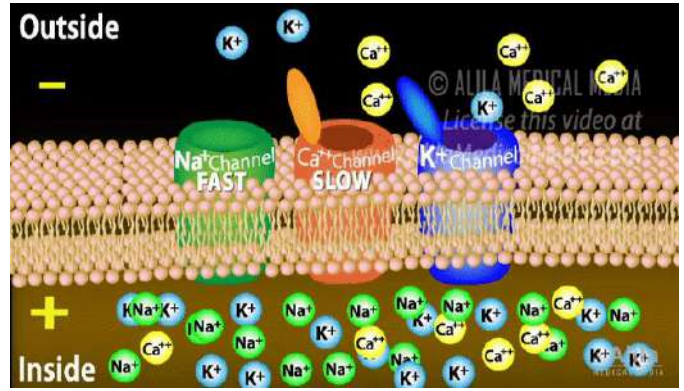
Estimulación Eléctrica Transcraneal

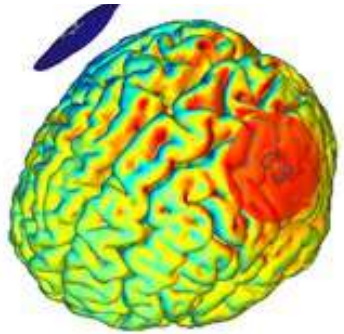




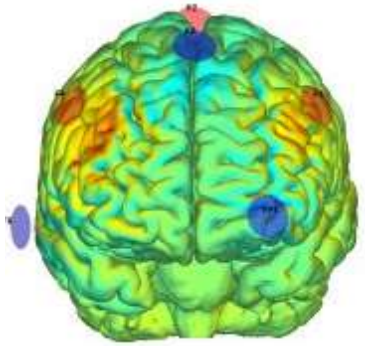




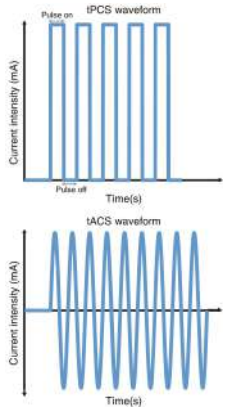




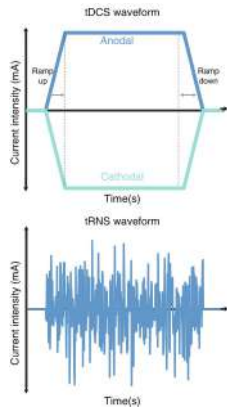
tDCS



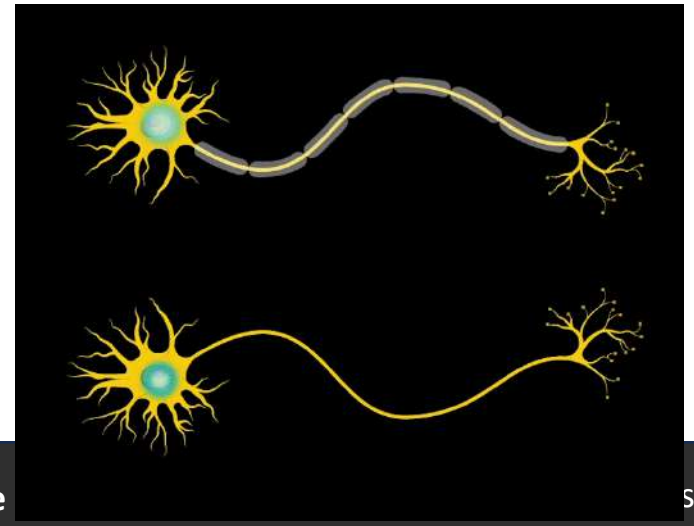
HD_tDCS



tACS



tRNS

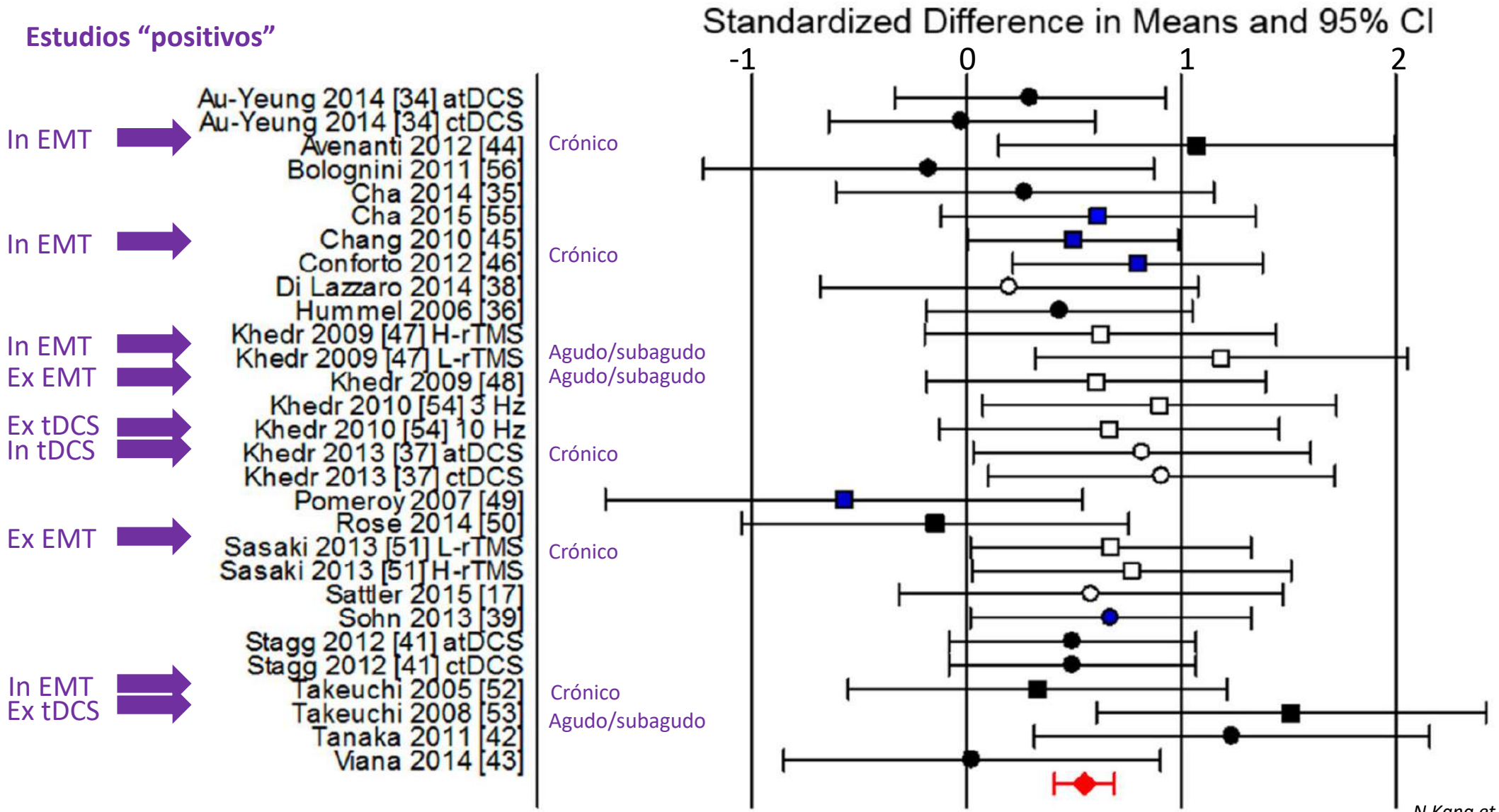


Puede ayudar la Estimulación Cerebral No Invasiva?

SI

… ayudar en la recuperación de la mano plégica…?

Estudios "positivos"



N Kang et al. Brain Stimulation 2016

ECNI y rehabilitación motora

My NCBI Collection – NIBS motor rehab

View in My NCBI

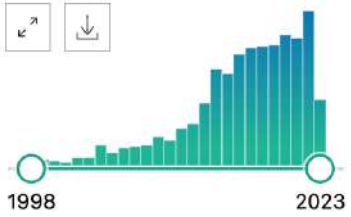
738 results

Page

All (738)

Review (115)

RESULTS BY YEAR

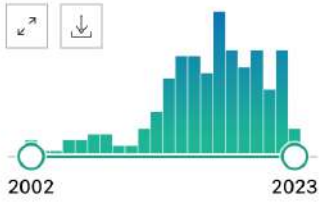


Clinical Trials

All (159)

Review (0)

RESULTS BY YEAR

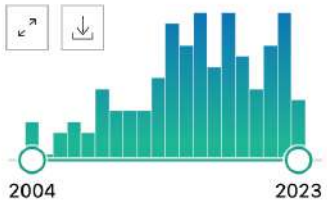


Reviews

All (115)

Review (115)

RESULTS BY YEAR

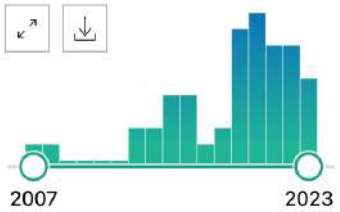


Sistematic Reviews

All (41)

Review (18)

RESULTS BY YEAR



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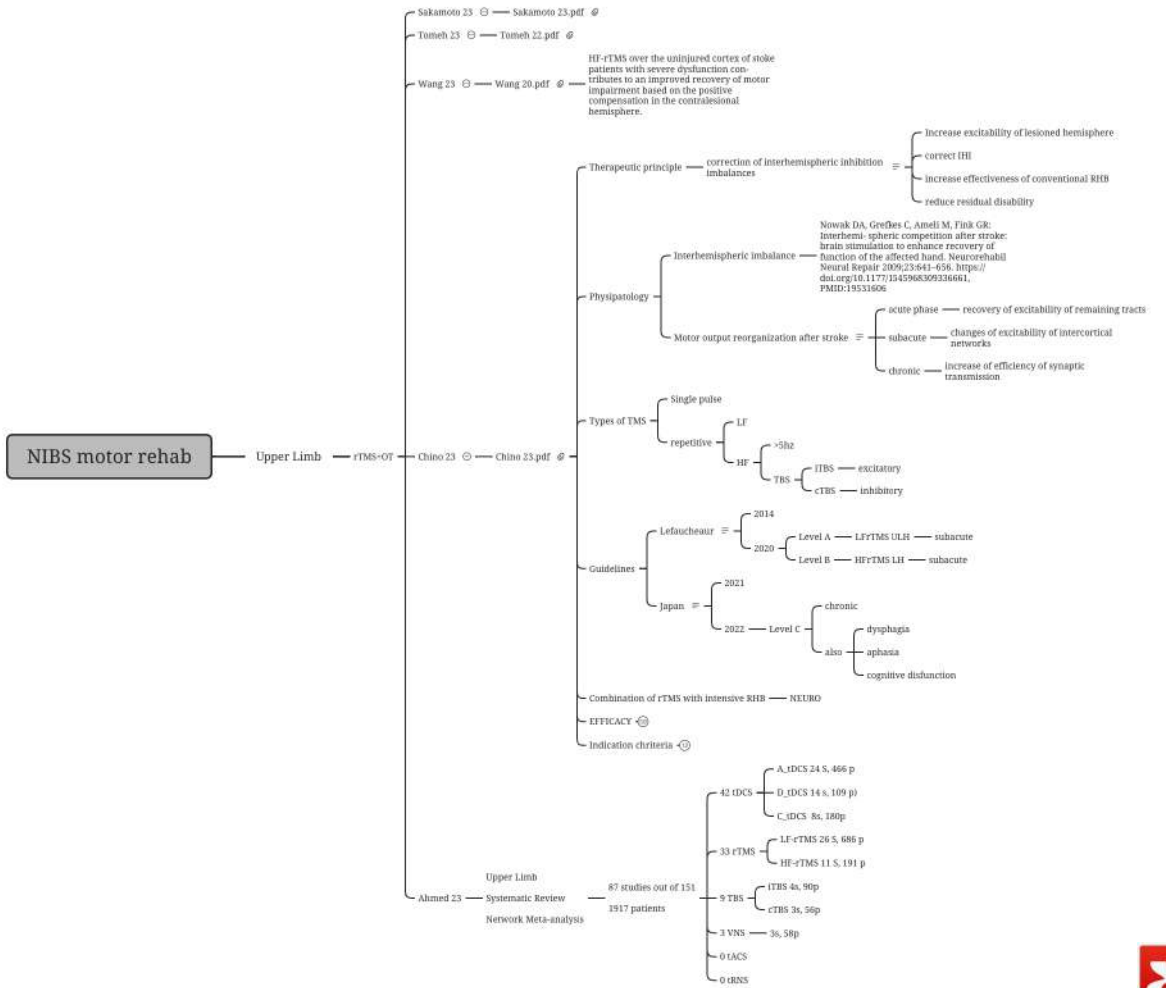

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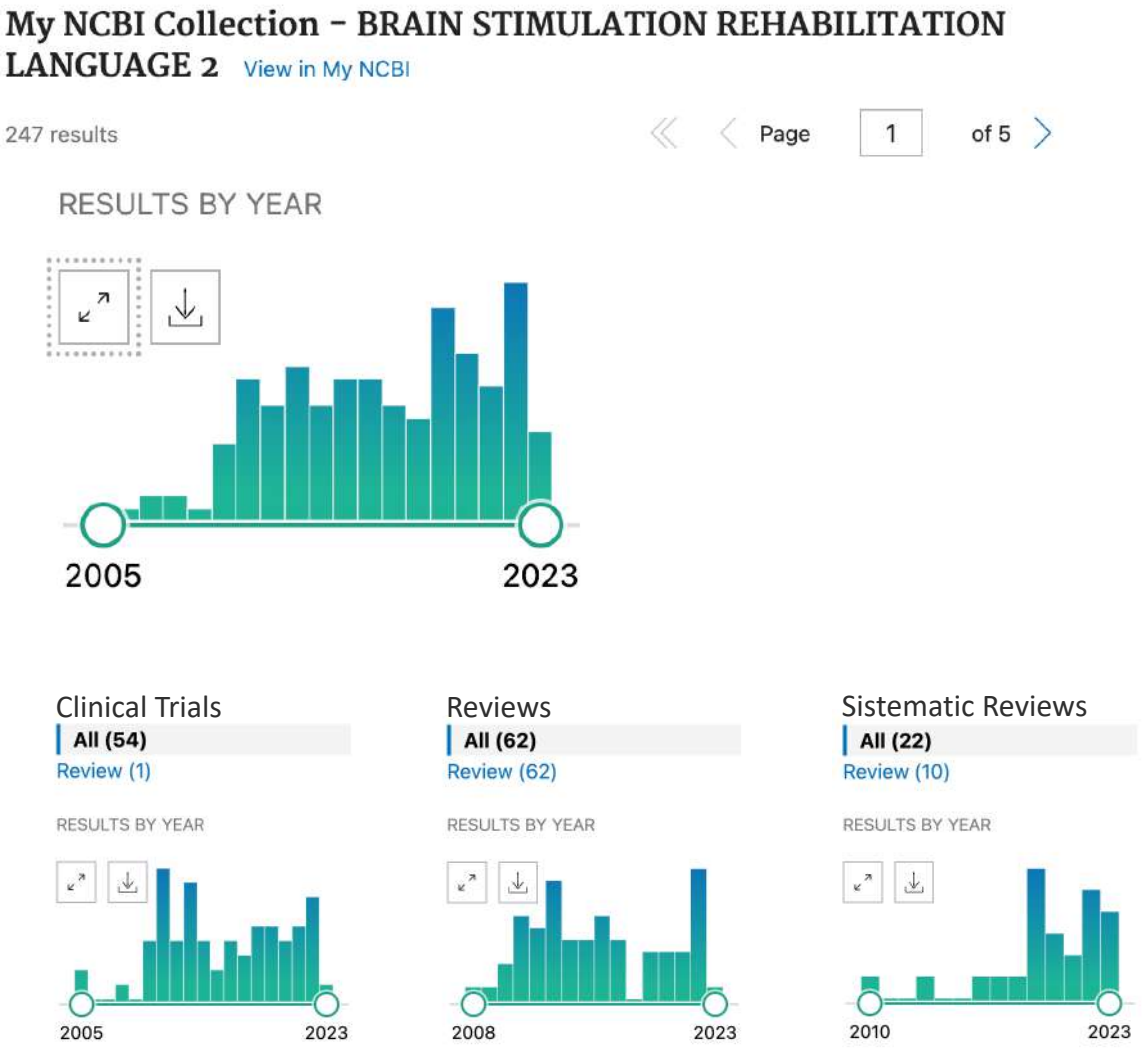
ECNI y Lenguaje



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- Afasia Motora
- Afasia de comprensión
- Afasia global
- Afasia Primaria Progresiva
- Anomia
- Demencia fronto temporal
- Desarrollo de lenguaje
- Tartamudez
- Distonía laríngea
- Disfagia
- Tumores

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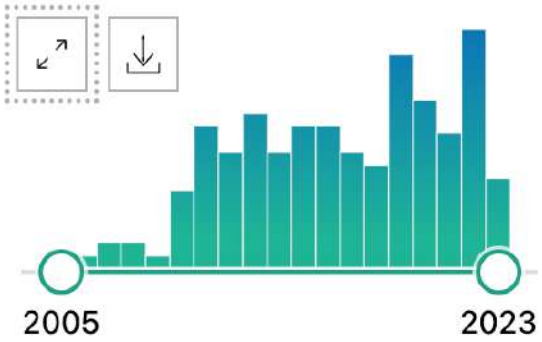
ECNI y Lenguaje

My NCBI Collection – BRAIN STIMULATION REHABILITATION LANGUAGE 2 View in My NCBI

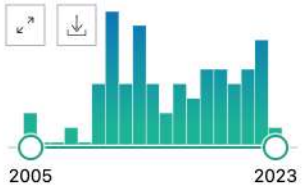
247 results Page 1 of 5

RESULTS BY YEAR



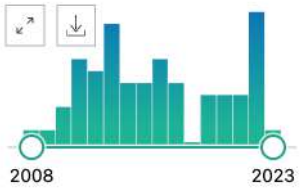
Clinical Trials
All (54)
Review (1)

RESULTS BY YEAR



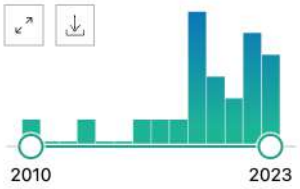
Reviews
All (62)
Review (62)

RESULTS BY YEAR



Sistematic Reviews
All (22)
Review (10)

RESULTS BY YEAR



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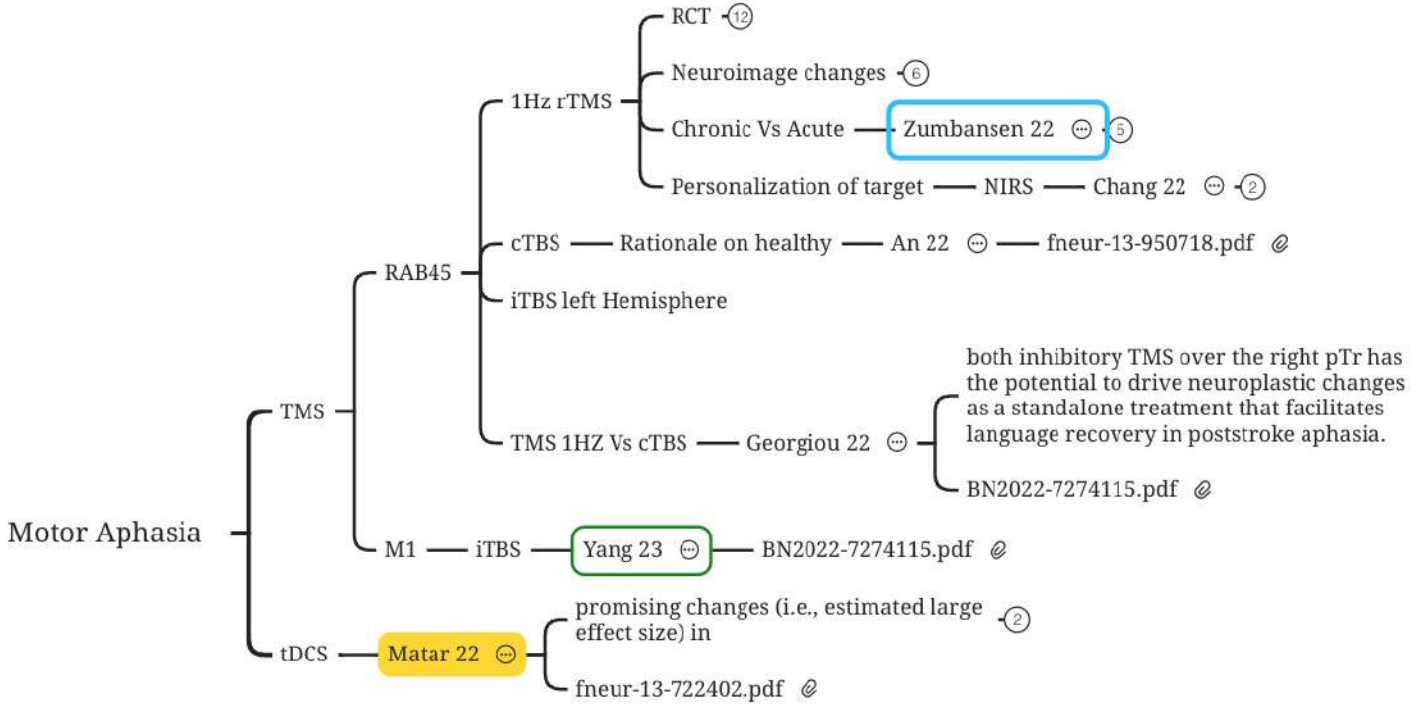

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Puede ayudar la Estimulación Cerebral No Invasiva?

Cómo?

… después de un Ictus?

- ¿Por qué se altera la capacidad de utilizar la mano o de hablar después de un ictus?
- ¿Qué se altera después del Ictus?
- ¿Cómo recuperar la funcionalidad perdida?

… después de un Ictus?

- ¿**Por qué se altera** la capacidad de utilizar la mano o de hablar después de un ictus?

- ¿**Qué se altera** después del Ictus?

- ¿**Cómo recuperar** la funcionalidad perdida?

¿Qué queremos rehabilitar o recuperar después de una lesión?

Movimientos Vs Acciones

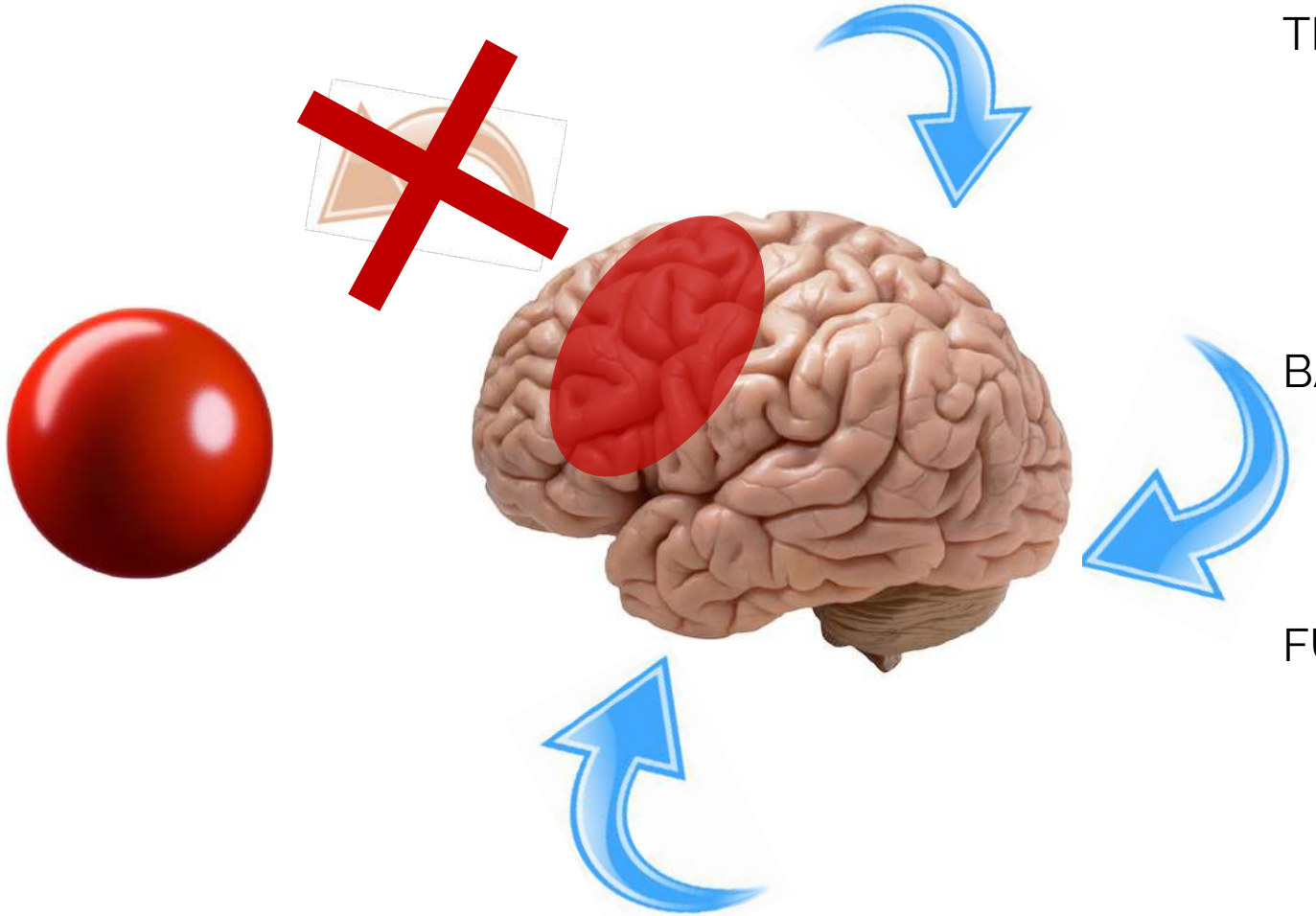
- No hacemos movimientos, sino acciones

Movimientos Vs Acciones

- No hacemos movimientos, sino acciones

Movimientos Vs Acciones

- No hacemos movimientos, sino acciones



TENIS

BALONCESTO

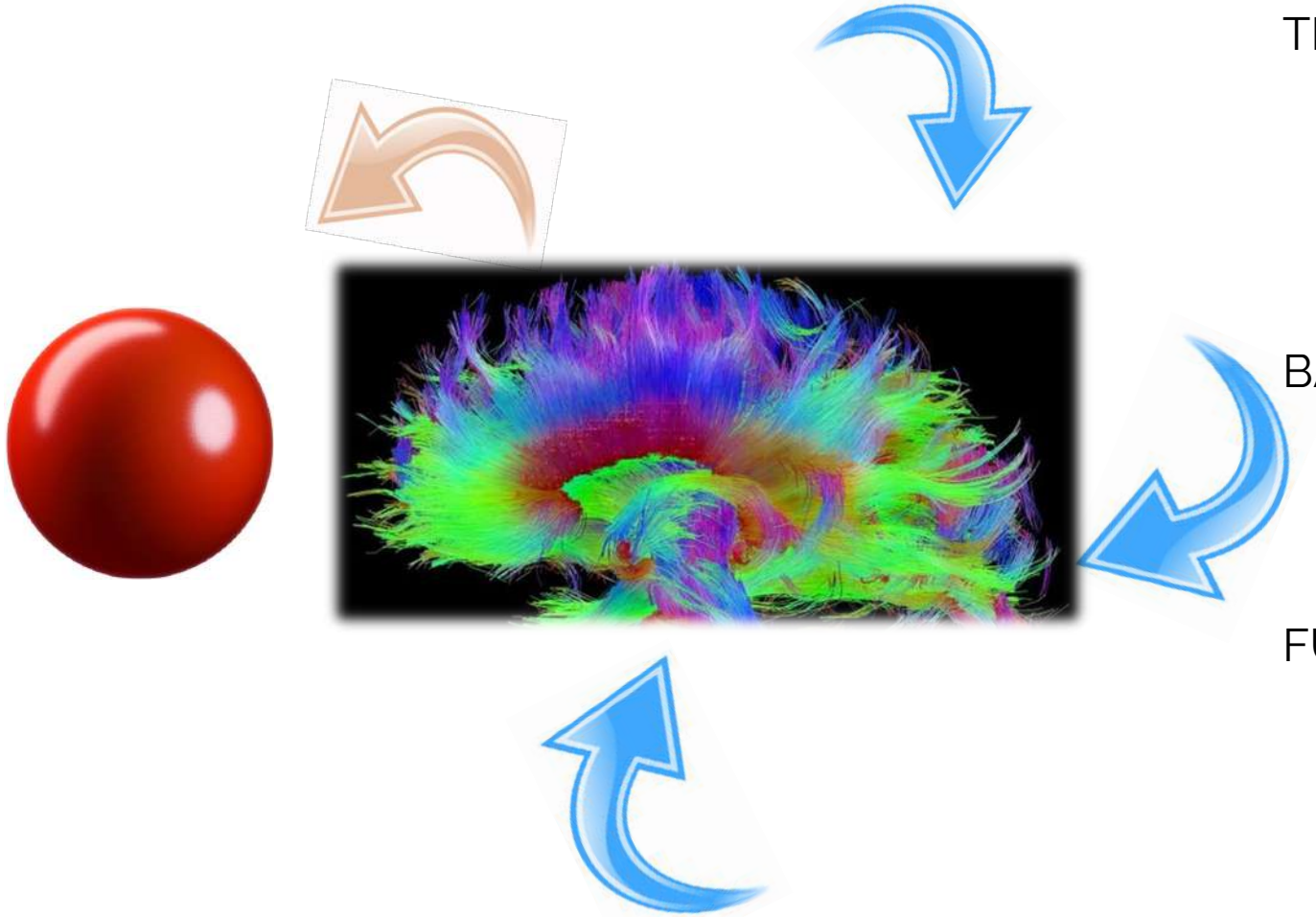
FÚTBOL

GOLF

➢ Evocadas por estímulos específicos

Movimientos Vs Acciones

- No hacemos movimientos, sino acciones



TENIS

BALONCESTO

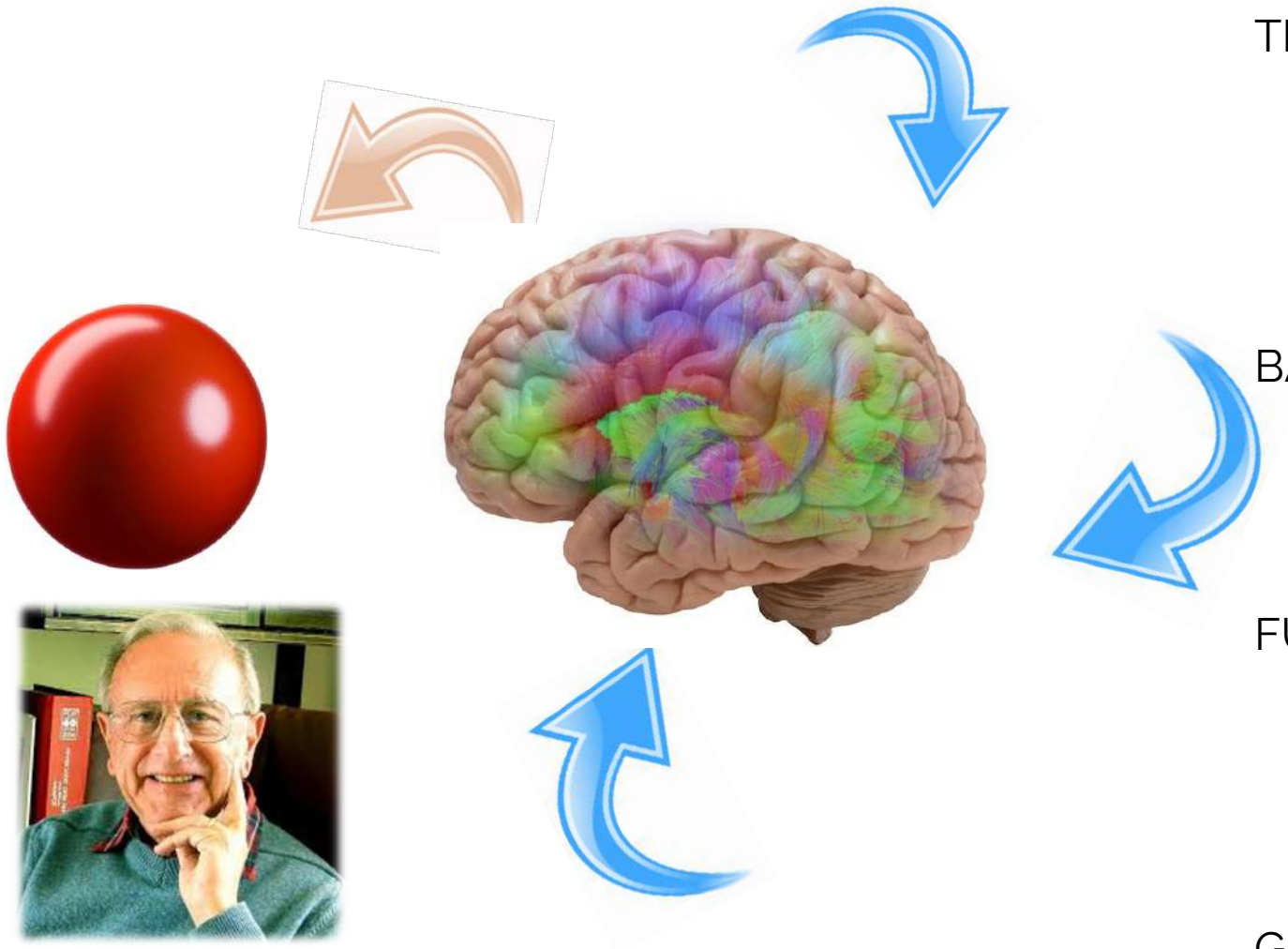
FÚTBOL

GOLF

➢ Evocadas por estímulos específicos

Movimientos Vs Acciones

- No hacemos movimientos, sino acciones



Joaquin Fuster - Barcelona, 1930

TENIS

BALONCESTO

FÚTBOL

GOLF

- Evocadas por estímulos específicos

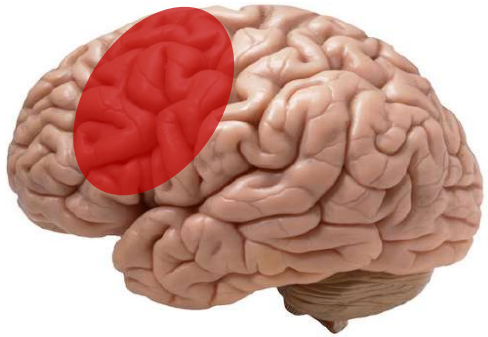
Recuperar la funcionalidad de la extremidad superior después de un ictus consiste en recuperar patrones de conexión útiles

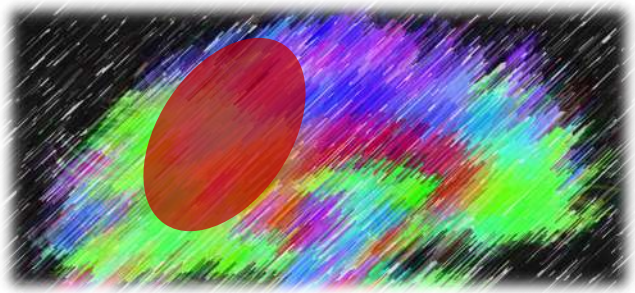
Para desarrollar acciones adecuadas a cada estímulo específico

¿Cuál es el truco?

Inducir la activación de circuitos adecuados para que cada estímulo evoque la respuesta motora deseada.

- ¿Como podemos modular la actividad de los circuitos para que rehabilitación sea más efectiva?
  - Potenciar las conexiones adecuadas
  - Interferir actvidad inadeacuada
    - No tenemos un plan de emergència para las lesiones cerebrales





Evidencias

Clin Neurophysiol. 2020 Feb;131(2):474-528. doi: 10.1016/j.clinph.2019.11.002.

Contents lists available at ScienceDirect

Clinical Neurophysiology

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

Evidence-based guidelines on the therapeutic use of repetitive transcranial magnetic stimulation (rTMS): An update (2014–2018)

Jean-Pascal Lefaucheur[a,b,*], André Aleman[c], Chris Baeken[d,e,f], David H. Benninger[g], Jérôme Brunelin[h], Vincenzo Di Lazzaro[i], Saša R. Filipović[j], Christian Grefkes[k,l], Alkomiet Hasan[m], Friedhelm C. Hummel[n,o,p], Satu K. Jääskeläinen[q], Berthold Langguth[r], Letizia Leocani[s], Alain Londero[t], Raffaele Nardone[u,v,w], Jean-Paul Nguyen[x,y], Thomas Nyffeler[z,aa,ab], Albino J. Oliveira-Maia[ac,ad,ae], Antonio Oliviero[af], Frank Padberg[m], Ulrich Palm[m,ag], Walter Paulus[ah], Emmanuel Poulet[h,ai], Angelo Quartarone[aj], Fady Rachid[ak], Irena Rektorová[al,am], Simone Rossi[an], Hanna Sahlsten[ao], Martin Schecklmann[r], David Szekely[ap], Ulf Ziemann[aq]

- **Level A (definite efficacy):**
  - Analgesic effect of high-frequency (HF) rTMS of the primary motor cortex (M1) contralateral to the pain
  - Antidepressant effect of HF-rTMS of the left dorsolateral prefrontal cortex (DLPFC).
- **Level B recommendation (probable efficacy)**
  - antidepressant effect of low-frequency (LF) rTMS of the right DLPFC,
  - HF-rTMS of the left DLPFC for the negative symptoms of schizophrenia
  - **LF-rTMS of contralesional M1 in chronic motor stroke.**
- **Level C (possible efficacy)**
  - LF-rTMS of the left temporoparietal cortex in tinnitus and auditory hallucinations.
- **It remains to determine:**
  - How to optimize rTMS protocols and techniques to give them relevance in routine clinical practice.
  - Training to ensure the quality of the technical realization, guarantee the proper care of patients, and maximize the chances of success for professionals carrying out rTMS protocols
  - The therapeutic use of rTMS should be able to develop in the coming years.

Evidencias

Review > Clin Neurophysiol. 2017 Jan;128(1):56-92. doi: 10.1016/j.clinph.2016.10.087. Epub 2016 Oct 29.

Evidence-based Guidelines on the Therapeutic Use of Transcranial Direct Current Stimulation (tDCS)

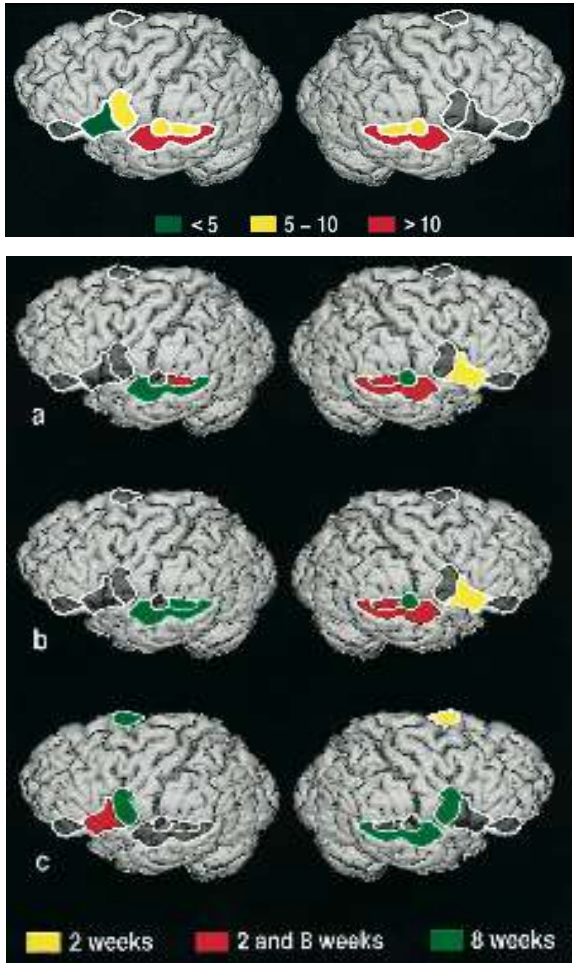
Jean-Pascal Lefaucheur [1], Andrea Antal [2], Samar S Ayache [3], David H Benninger [4], Jérôme Brunelin [5], Filippo Cogiamanian [6], Maria Cotelli [7], Dirk De Ridder [8], Roberta Ferrucci [6], Berthold Langguth [9], Paola Marangolo [10], Veit Mylius [11], Michael A Nitsche [12], Frank Padberg [13], Ulrich Palm [13], Emmanuel Poulet [14], Alberto Priori [15], Simone Rossi [16], Martin Schecklmann [9], Sven Vanneste [17], Ulf Ziemann [18], Luis Garcia-Larrea [19], Walter Paulus [2]

- **Level A (definite efficacy) for any indication.**
- **Level B recommendation (probable efficacy)**
  - (i) anodal tDCS of the left primary motor cortex (M1) (with right orbitofrontal cathode) in fibromyalgia;
  - (ii) anodal tDCS of the left dorsolateral prefrontal cortex (DLPFC) (with right orbitofrontal cathode) in major depressive episode without drug resistance;
  - (iii) anodal tDCS of the right DLPFC (with left DLPFC cathode) in addiction/craving.
- **Level C recommendation (possible efficacy)**
  - anodal tDCS of the left M1 (or contralateral to pain side, with right orbitofrontal cathode)
  - chronic lower limb neuropathic pain secondary to spinal cord lesion.
- **Level B recommendation (probable inefficacy)** is conferred on the absence of clinical effects of:
  - (i) anodal tDCS of the left temporal cortex (with right orbitofrontal cathode) in tinnitus;
  - (ii) anodal tDCS of the left DLPFC (with right orbitofrontal cathode) in drug-resistant major depressive episode.
- **It remains to be clarified whether:**
  - The probable or possible therapeutic effects of tDCS are clinically meaningful
  - How to optimally perform tDCS in a therapeutic setting.
  - Easy management and low cost of tDCS devices allow at home use by the patient
    - Ethical and legal concerns with regard to potential misuse or overuse.
  - We must be careful to avoid inappropriate applications of this technique by ensuring rigorous training of the professionals and education of the patients.

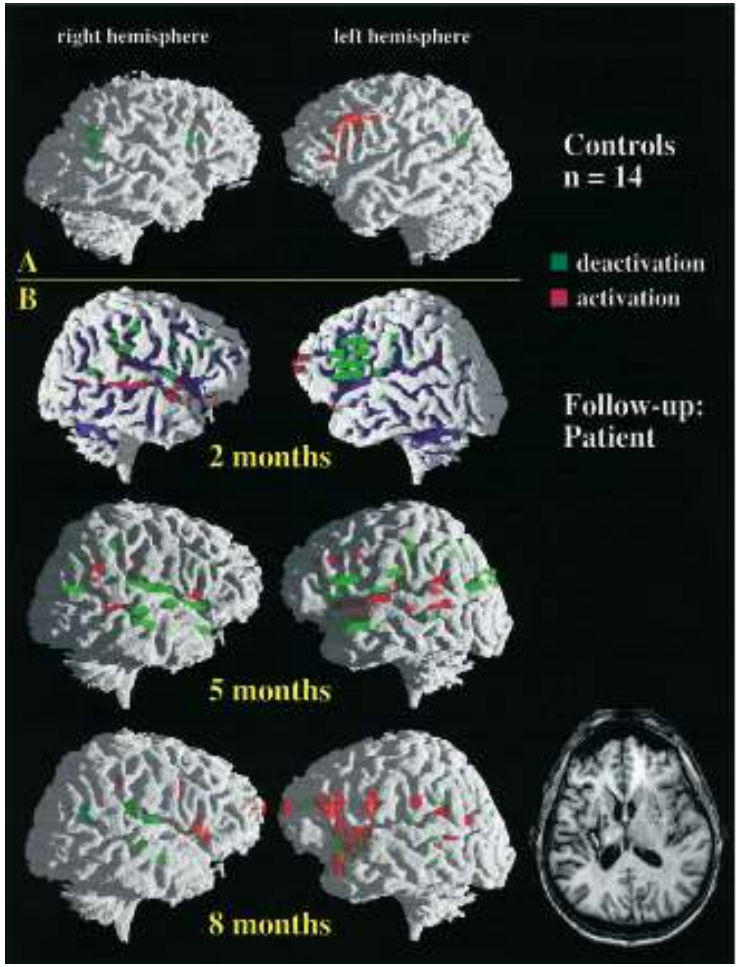
El principio de Mafalda

Basada en la evidencia
Vs
Predicitiva Personalizada Precisión

Cuando el déficit de la función no es la consecuencia directa de la lesión

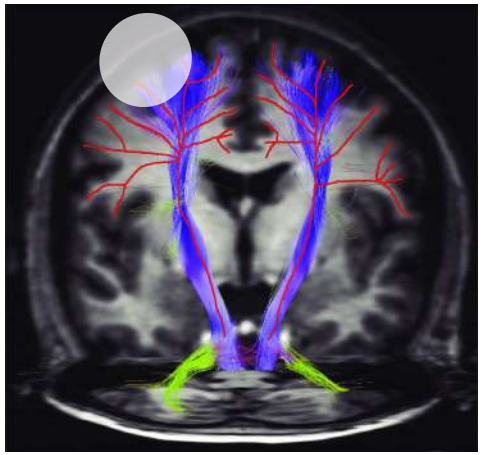


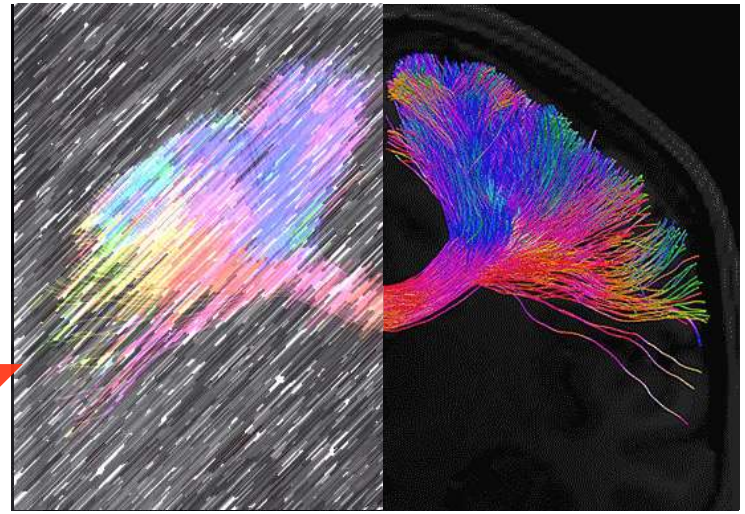
Heiss et al; 1999, Ann of Neurology



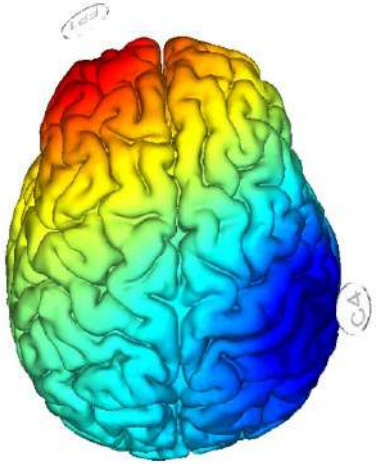
Hund-Georgiadis, et al; 2000, Neurology

La plasticidad siempre nos sorprende

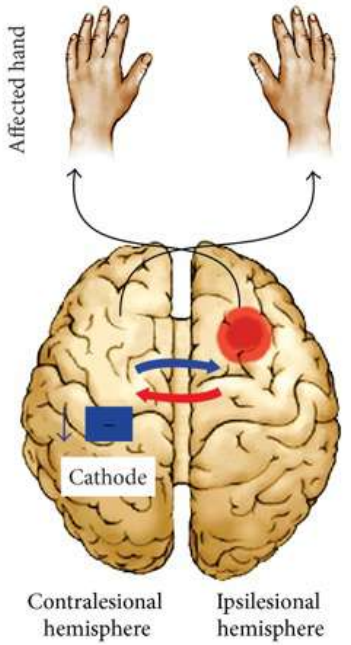




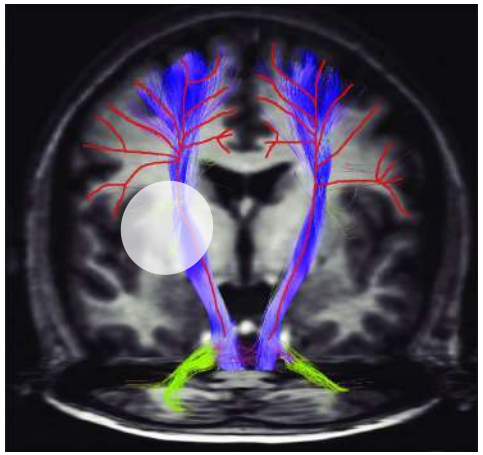
Constrained Induced Moviment Therapy

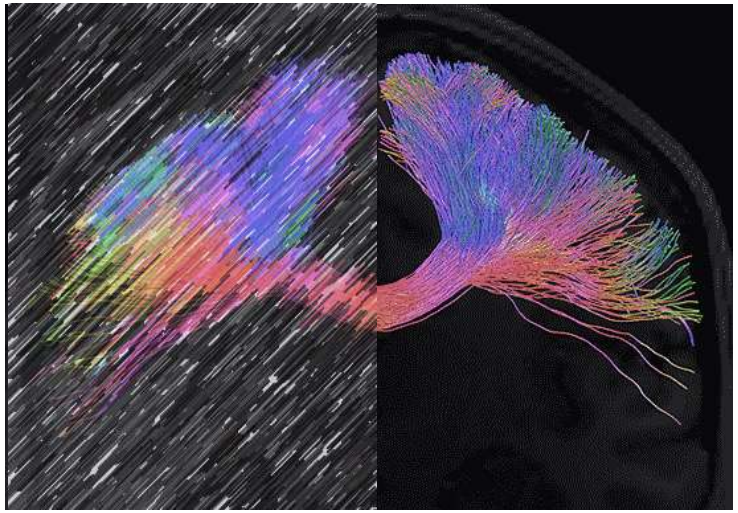


Neuromodulación

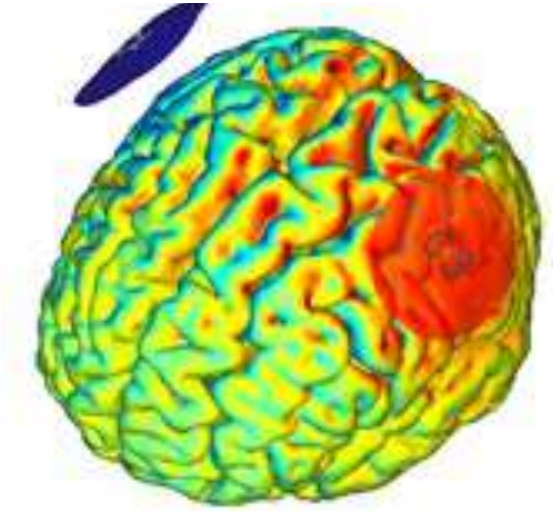


La plasticidad siempre nos sorprende

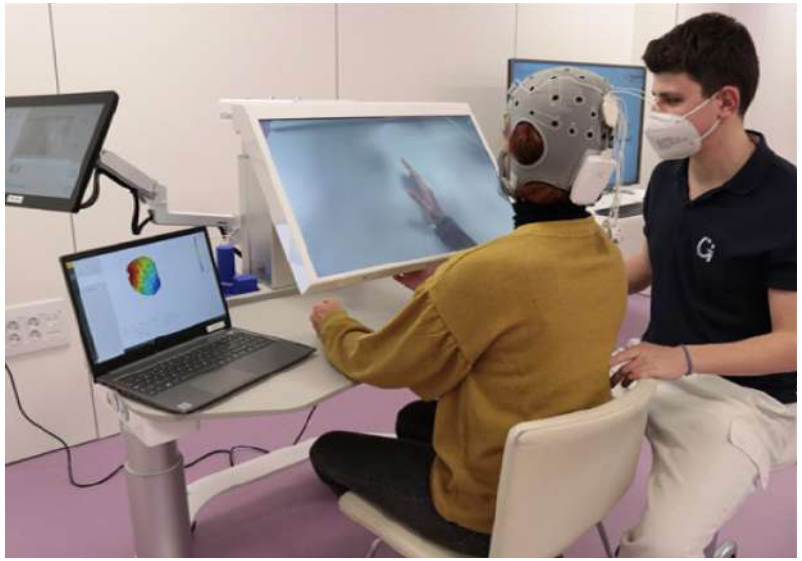




Constr ed Induced Movim herapy



Neuromodulación



Síntesis

- Base fisiopatológica
  - ❖ **Disminución excitabilidad del hemisferio lesionado**
  - ❖ **Aumento de excitabilidad áreas remotas (contralaterales)**
- Objetivo terapéutico
  - ❖ Aumenta la excitabilidad en el hemisferio lesionado
  - ❖ Corregir inhibición interhemisférica
- Patrón de cambios dinámicos
  - ❖ Fase aguda:
    - ➢ **recuperación excitabilidad de las conexiones remanentes**
  - ❖ Fase Sub aguda:
    - ➢ **Cambios de excitabilidad entre redes**
  - ❖ Fase crónica:
    - ➢ **Aumento de eficiencia de conectividad sináptica**

- rTMS
  - ✓ **LF-rTMS**
  - ✓ **HF-rTMS**
  - ✓ **iTBS**
  - ✓ **cTBS**
- tDCS
  - ✓ **A-tDCS**
  - ✓ **C-tDCS**
  - ✓ **D-tDCS**
  - ✓ **tACS**
  - ✓ **tRNS**

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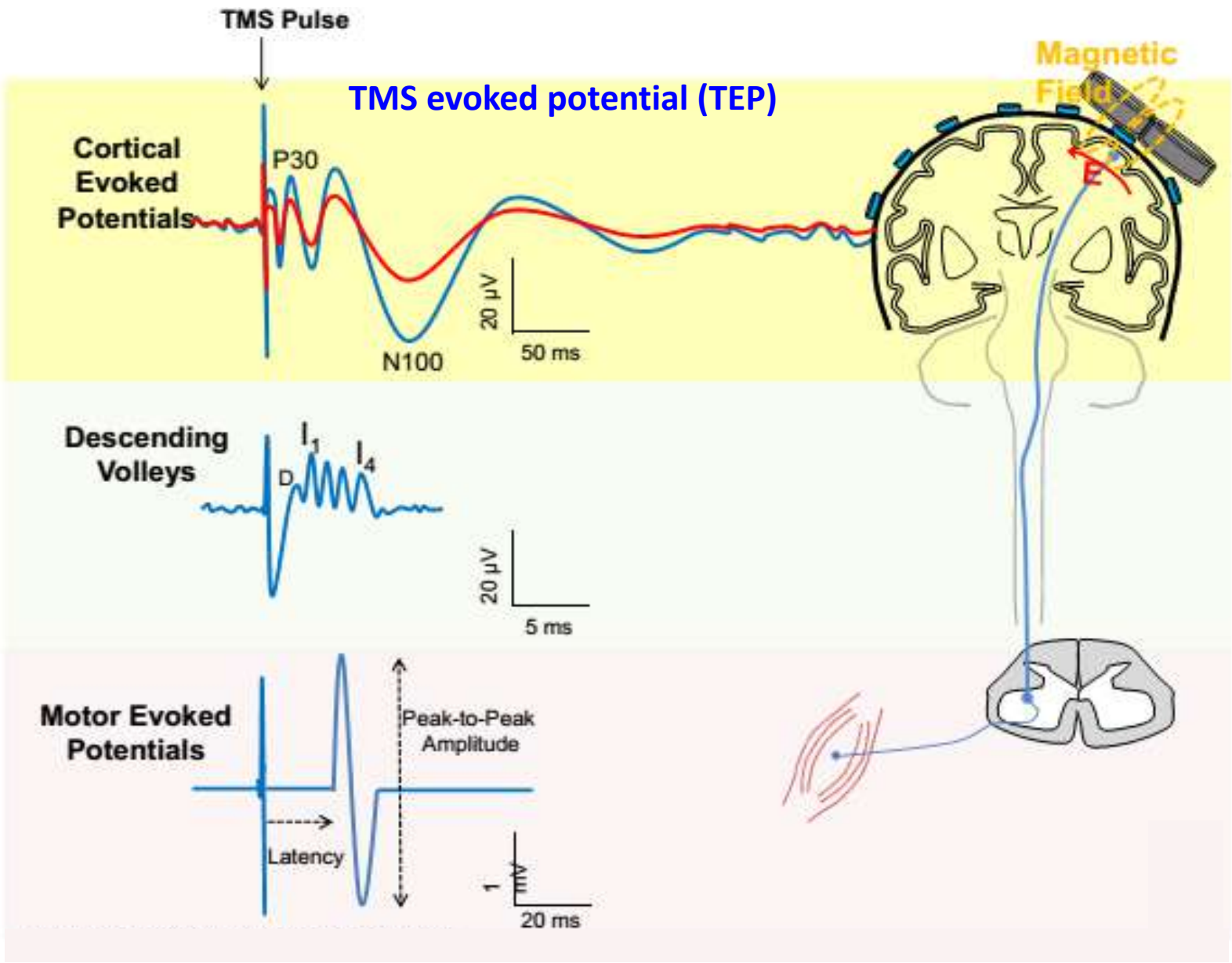
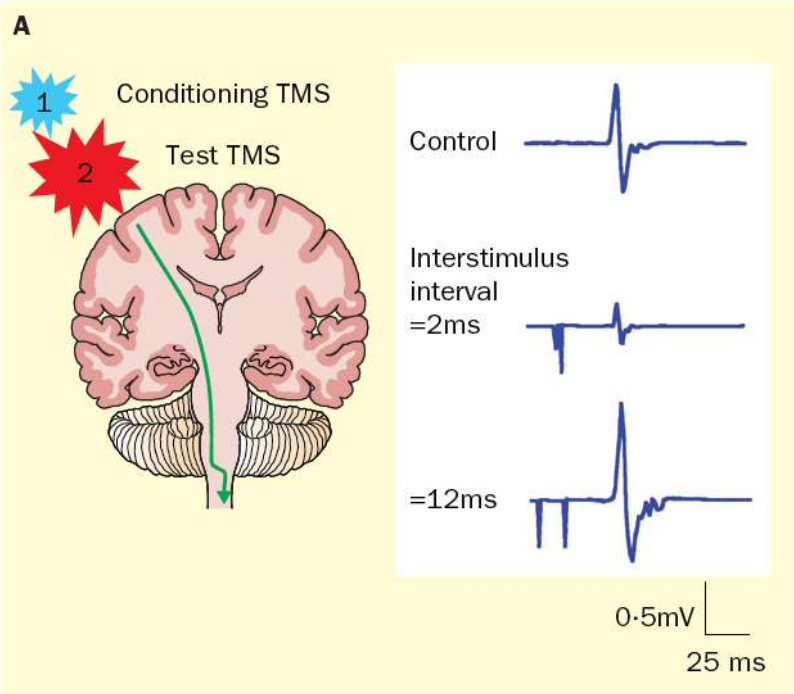
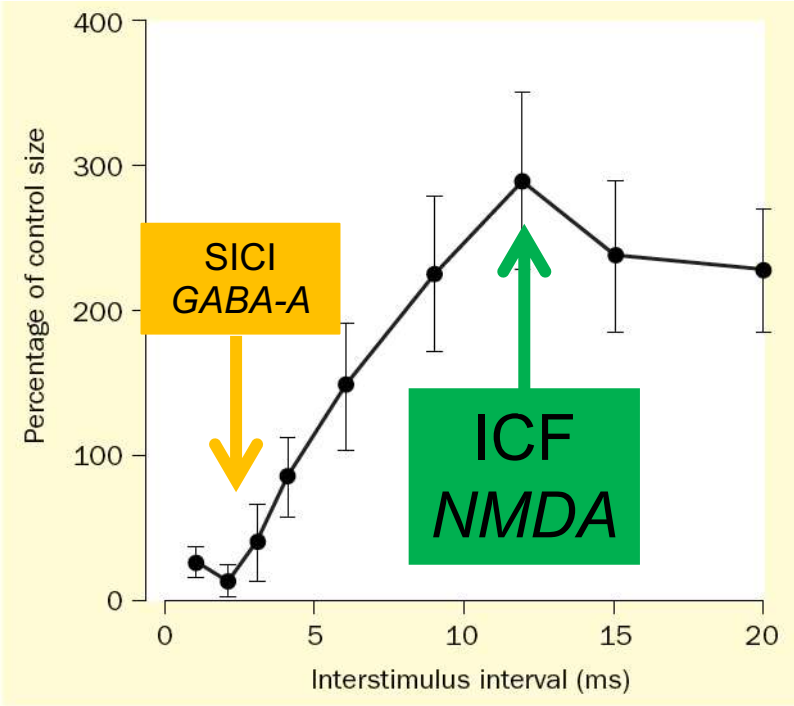
- rTMS
  - ✓ **LF-rTMS (HS):** crónico
  - ✓ **HF-rTMS (HL):** subagudo
  - ✓ **iTBS**
  - ✓ **cTBS (HS):** crónico
- tDCS
  - ✓ **A-tDCS (HL):** subagudo
  - ✓ **C-tDCS (HS):** crónico
  - ✓ **D-tDCS:** agudo
  - ✓ **tACS**
  - ✓ **tRNS**

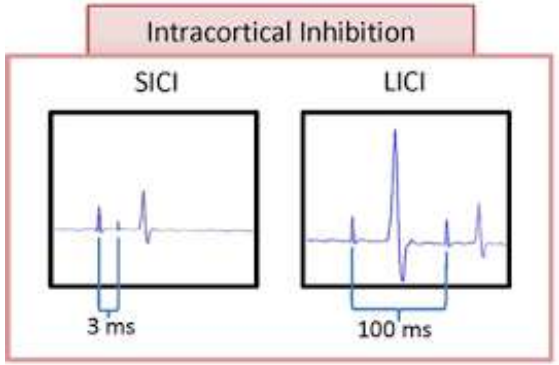
Hacia la personalización…


TMS Pulse
TMS evoked potential (TEP)
Magnetic Field
Cortical Evoked Potentials
P30
N100
20 µV
50 ms
Descending Volleys
I1
I4
D
20 µV
5 ms
Motor Evoked Potentials
Peak-to-Peak Amplitude
Latency
1 mV
20 ms

TMS: Paired-Pulse



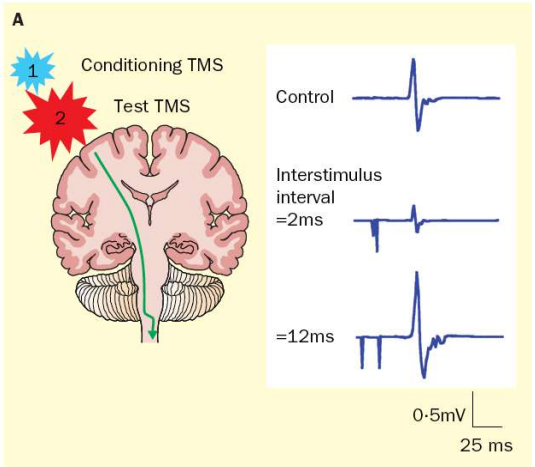


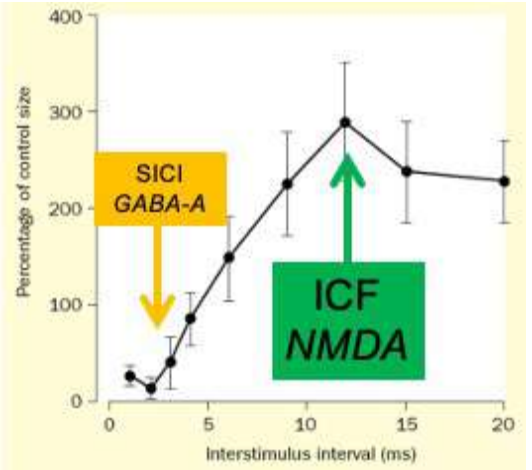


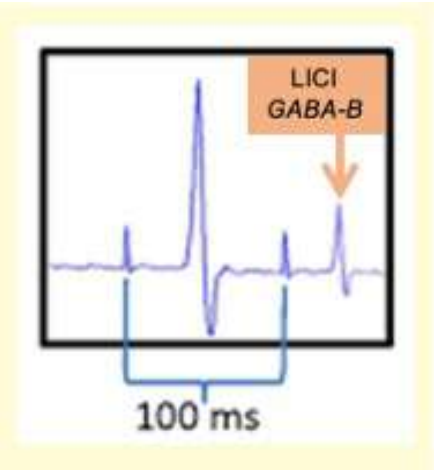
Kobayashi et al *Lancet Neurol* 03

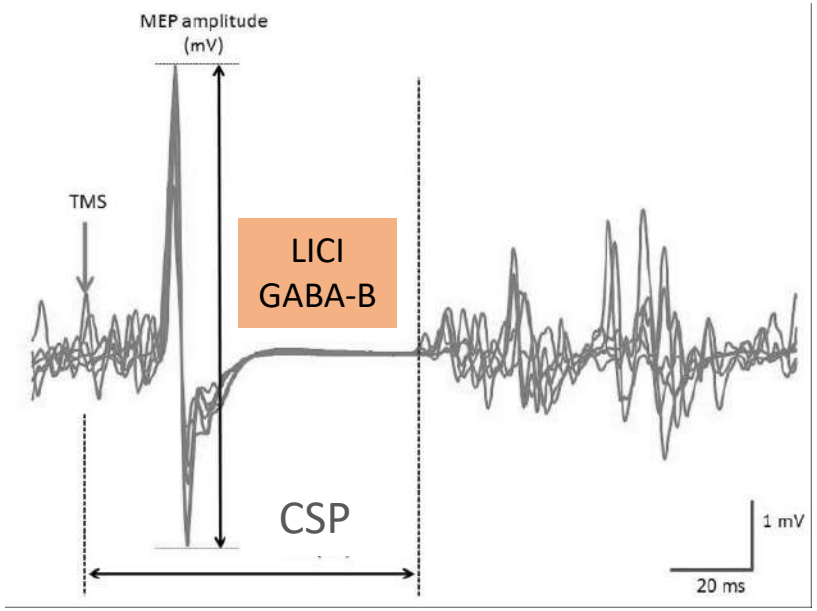
Correlato neurobiológico de paradigmas EMT en corteza motora

- Equilibrio excitador - inhibidor
  - GABA $_A$
    - SICI (short intra cortical inhibition)
  - GABA $_B$
    - LICI (Long intra cortical inhibition)
    - CSP (Silent Period)
  - NMDA Glutamato
    - ICF (Intra cortical facilitation)
  - ACh
    - SAI (short latency afferent inhibition)
- Plasticity mechanisms
  - PAS (paired associtative stimulation)
    - LTP (25msec interval)
    - LTD (10msec interval)
  - rTMS modulation
  - iTBS / cTBS modulation









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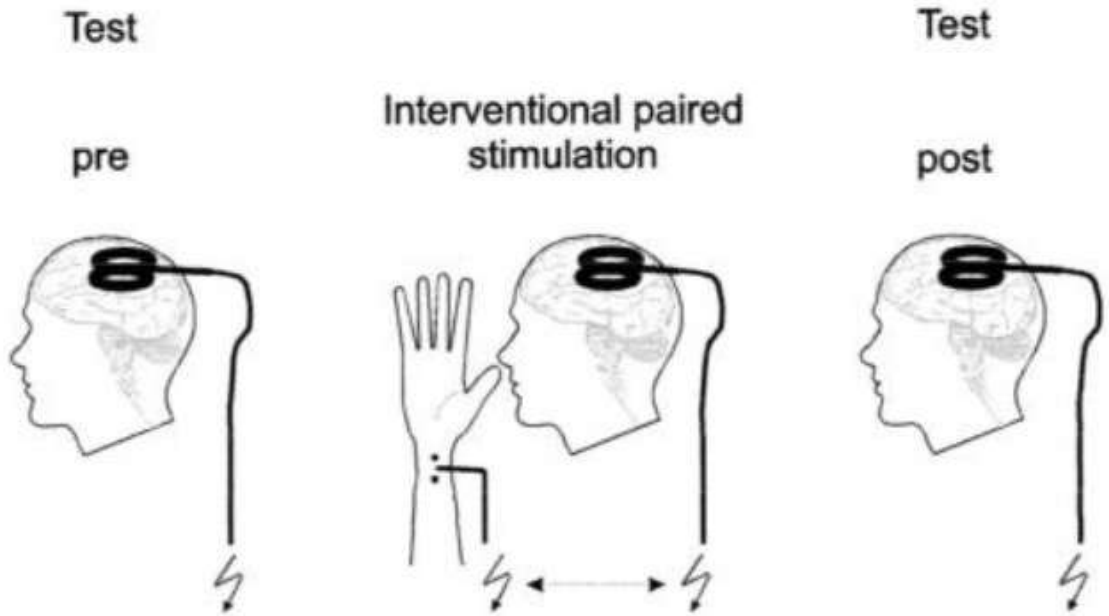
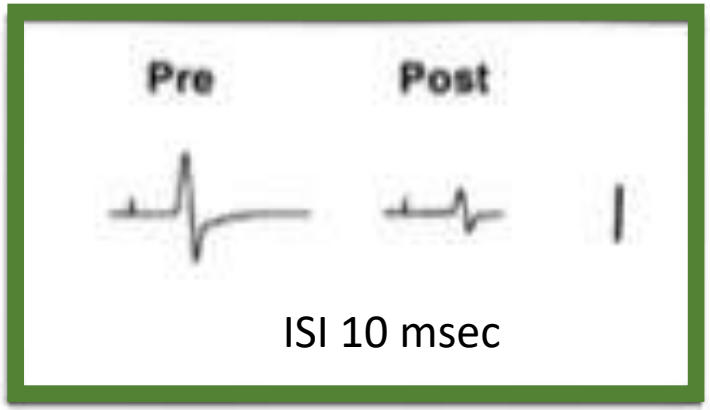
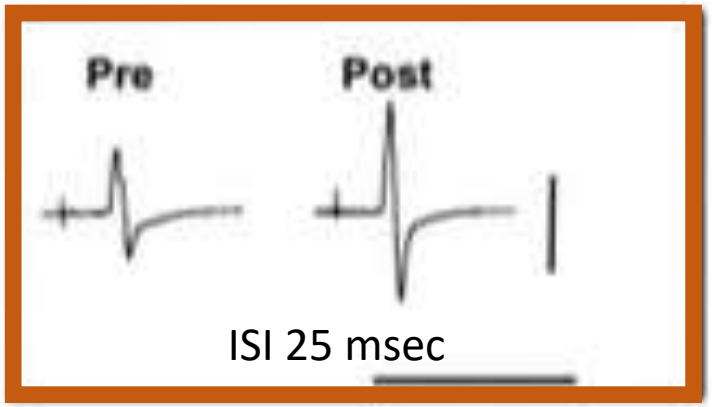






Modulando la excitabilidad cortical mediante rTMS

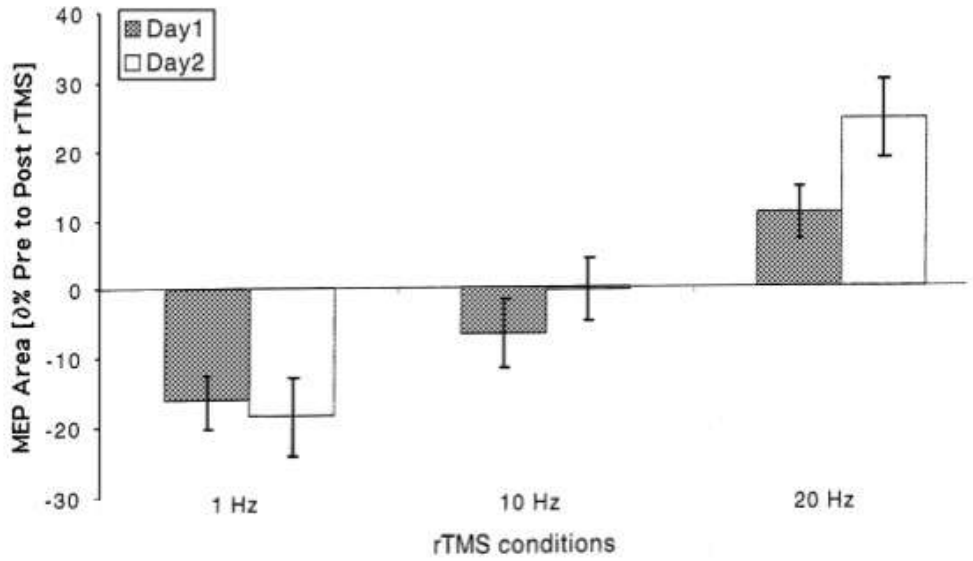
ELSEVIER

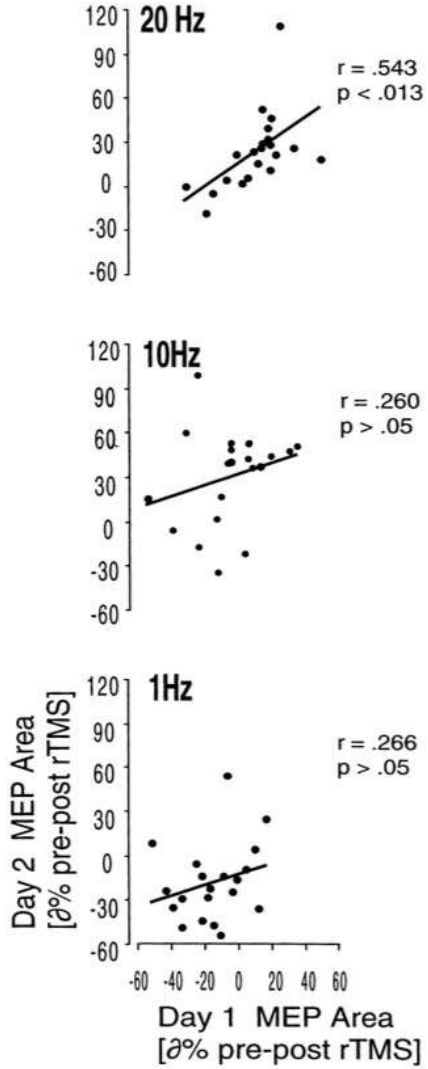
Clinical Neurophysiology 111 (2000) 800–805

www.elsevier.com/locate/clinph

Modulation of corticospinal excitability by repetitive transcranial magnetic stimulation

Fumiko Maeda[a, b], Julian Paul Keenan[a], Jose Maria Tormos[c, d], Helge Topka[e], Alvaro Pascual-Leone[a, d,*]





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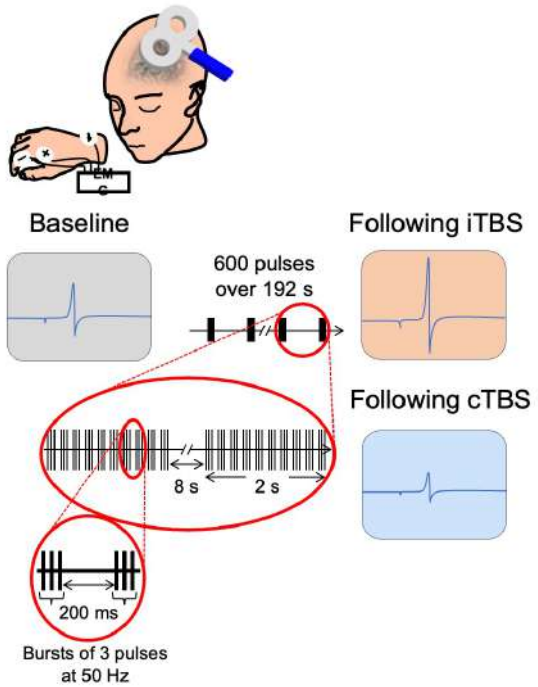
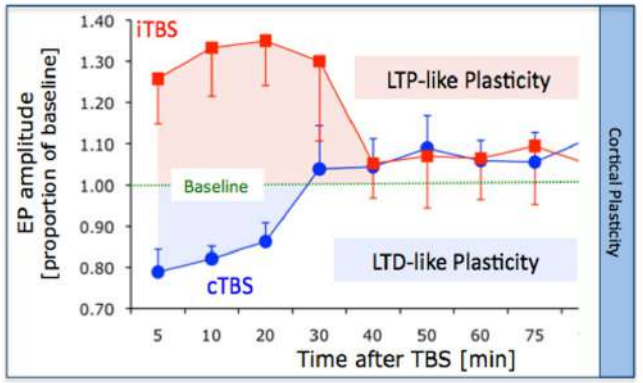




Frontiers Synaptic Plasticity 2011; *Brain Topography* 2011; *Eur J Neurosci* 2012

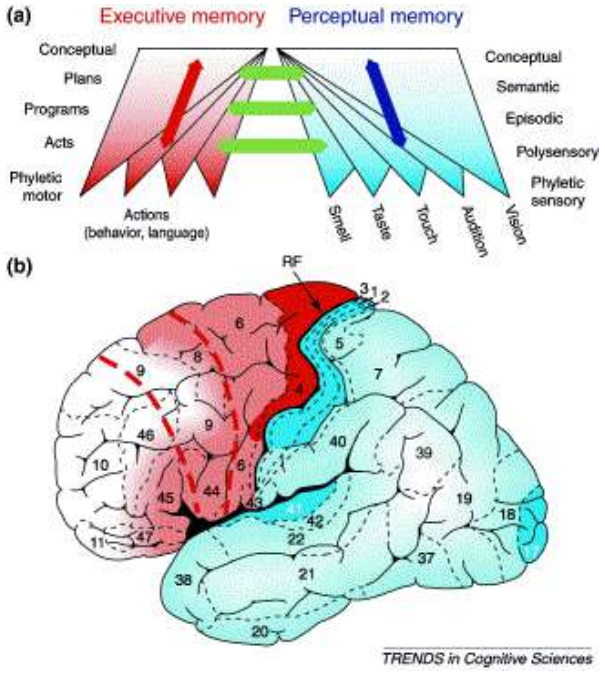
Estimulación cerebral no invasiva en rehabilitación de la memoria

Rev Neurol. 2010 Mar 3;50 Suppl 3:S3-10.

[The reticular paradigm of cortical memory].

[Article in Spanish]

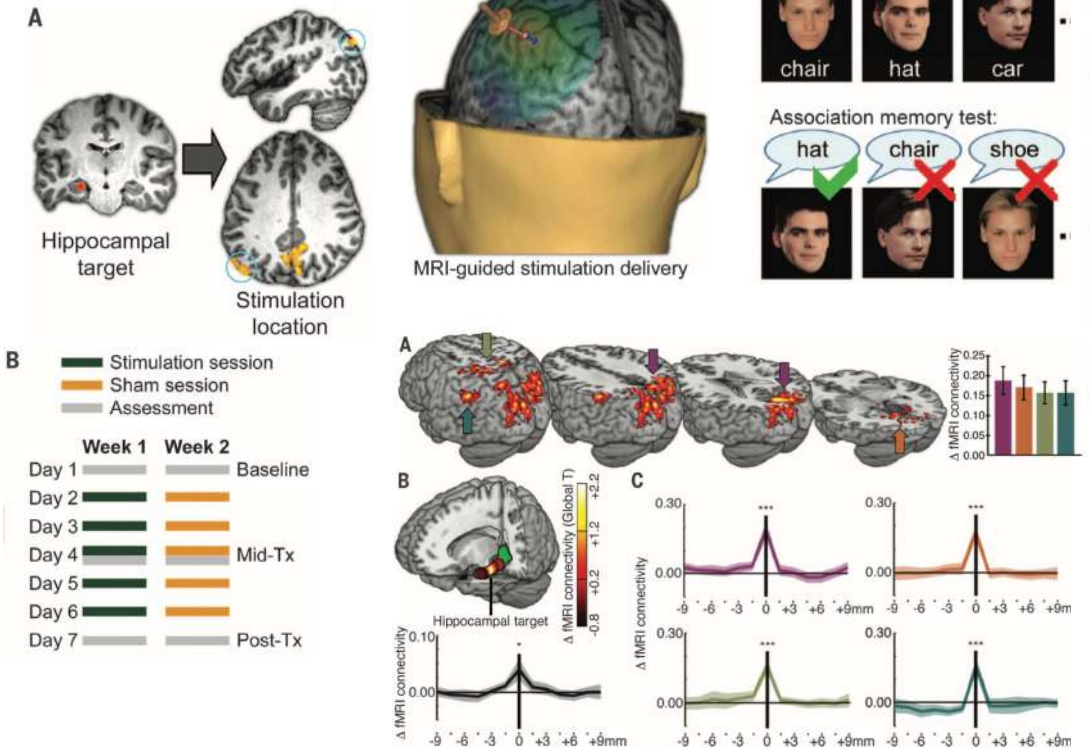
Fuster JM[1].



Science. 2014 Aug 29;345(6200):1054-7. doi: 10.1126/science.1252900.

Targeted enhancement of cortical-hippocampal brain networks and associative memory.

Wang JX, Rogers LM, Gross EZ, Ryals AJ, Dokucu ME, Brandstatt KL, Hermiller MS, **Voss JL.**



El hipocampo apoya la memoria asociativa al interactuar con regiones cerebrales funcionalmente distintas y distribuidas

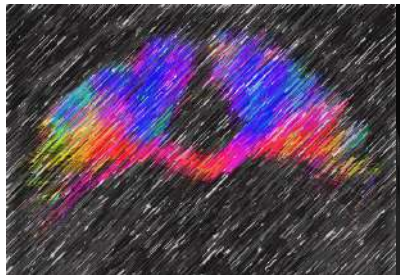
Estimulación cerebral no invasiva en rehabilitación de funciones ejecutivas

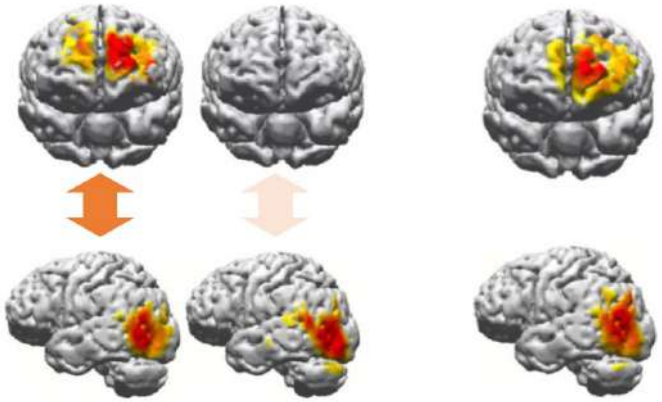
Ensayo controlado aleatorio del efecto potenciador de la estimulación transcraneal de ruido aleatorio (tRNS) en la rehabilitación cognitiva de pacientes con lesión cerebral traumática

La Marató 3

GUTTMANN neuro personal trainer

Mejoría rendimiento cognitivo 60% pacientes





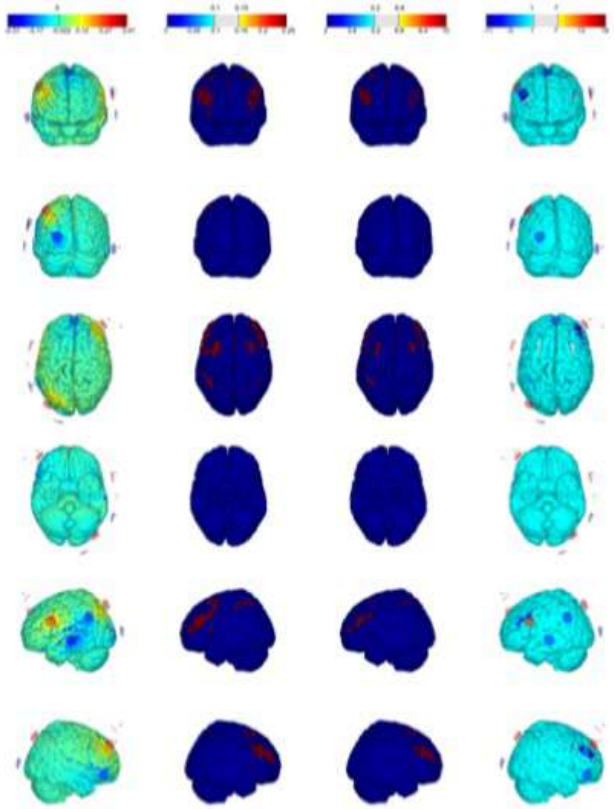
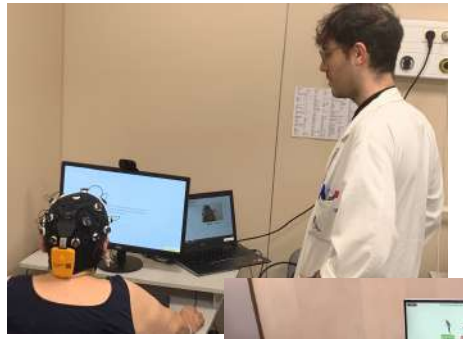


Figure 1 – Optimization A: $I_{Max} = 2.0mA$, 8 channels montage, Max weight(8-channel solution). From Left to right: Normal component of the E-field E_n (V/m), target E-field (V/m), target weight and ERNI* (mV^2/m^2) for grey matter.



Adrià Garcia

Emiliano Santarnecchi

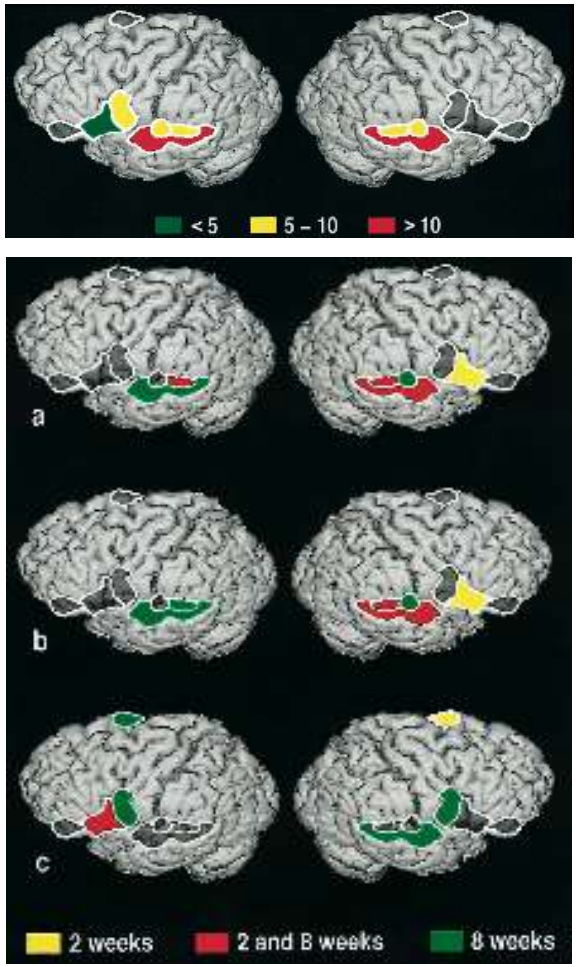
Álvaro Pascual-Leone

Aureli Soria-Frisch

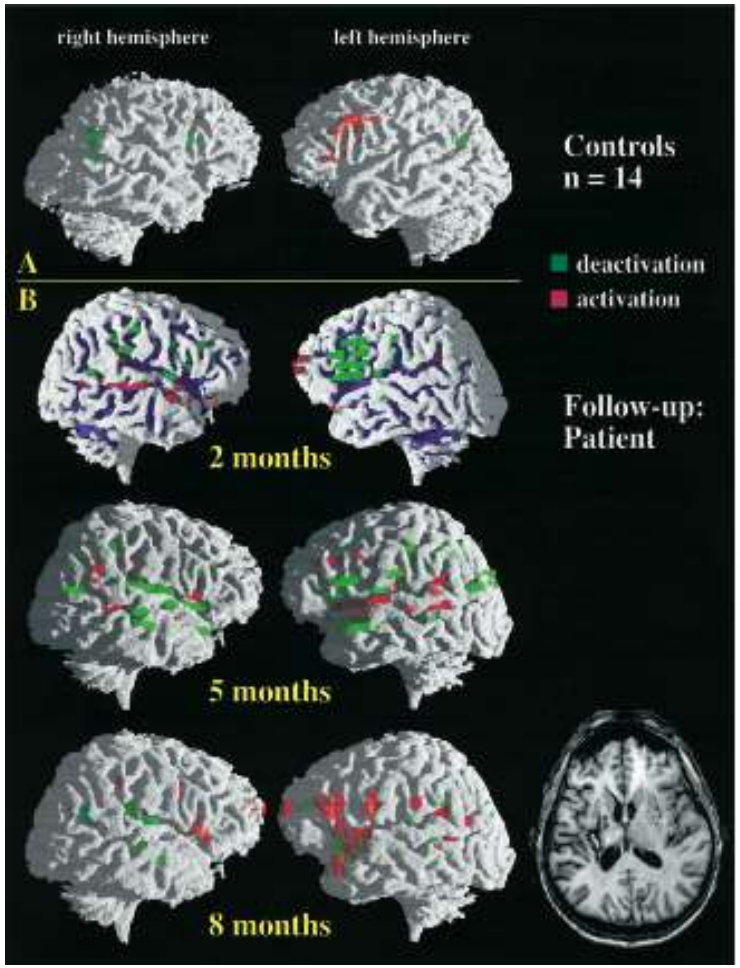
Alberto García-Molina

Marta Castellano

Cuando el déficit de la función no es la consecuencia directa de la lesión



Heiss et al; 1999, Ann of Neurology



Hund-Georgiadis, et al; 2000, Neurology

Muchas gracias!!!!