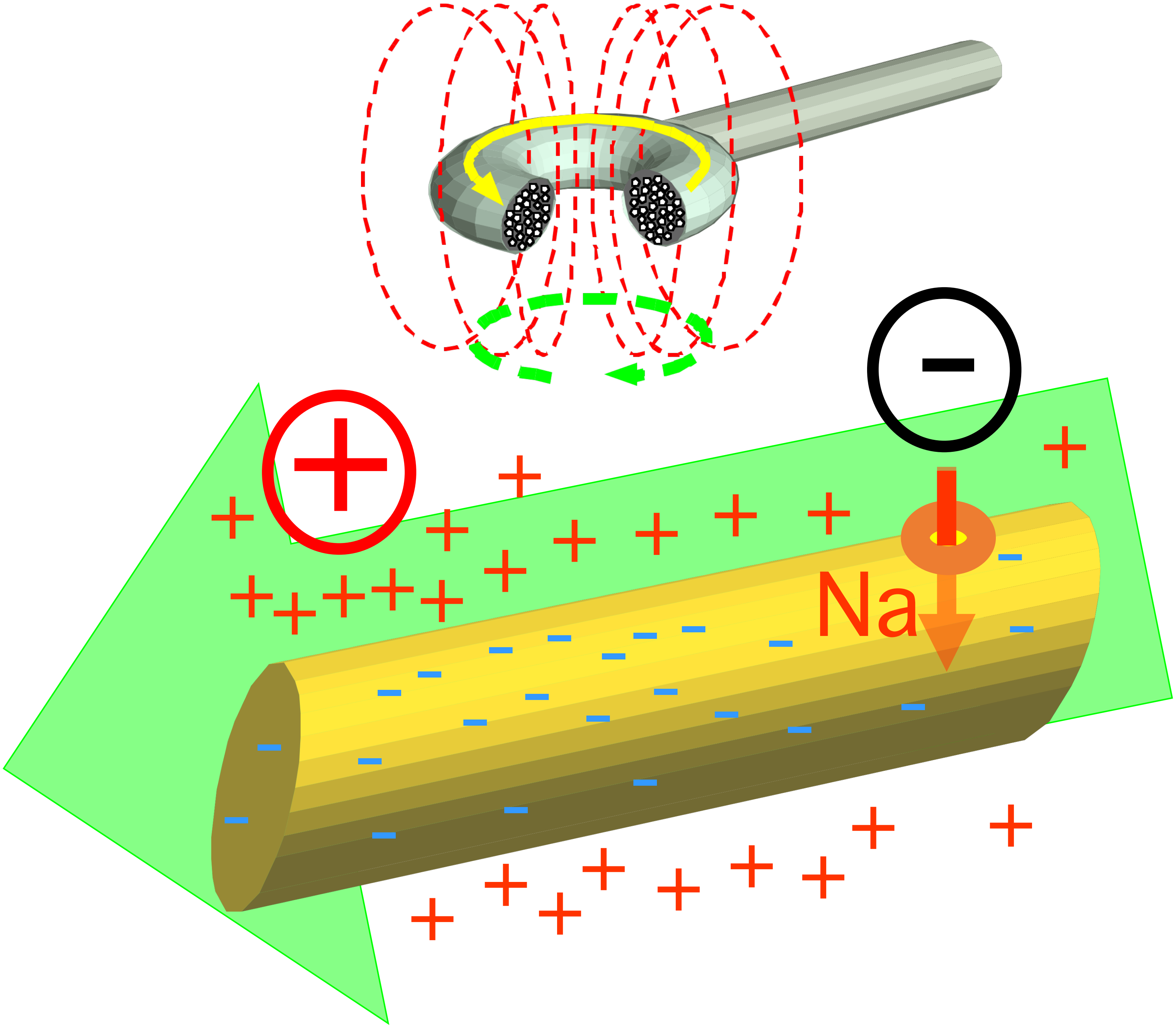
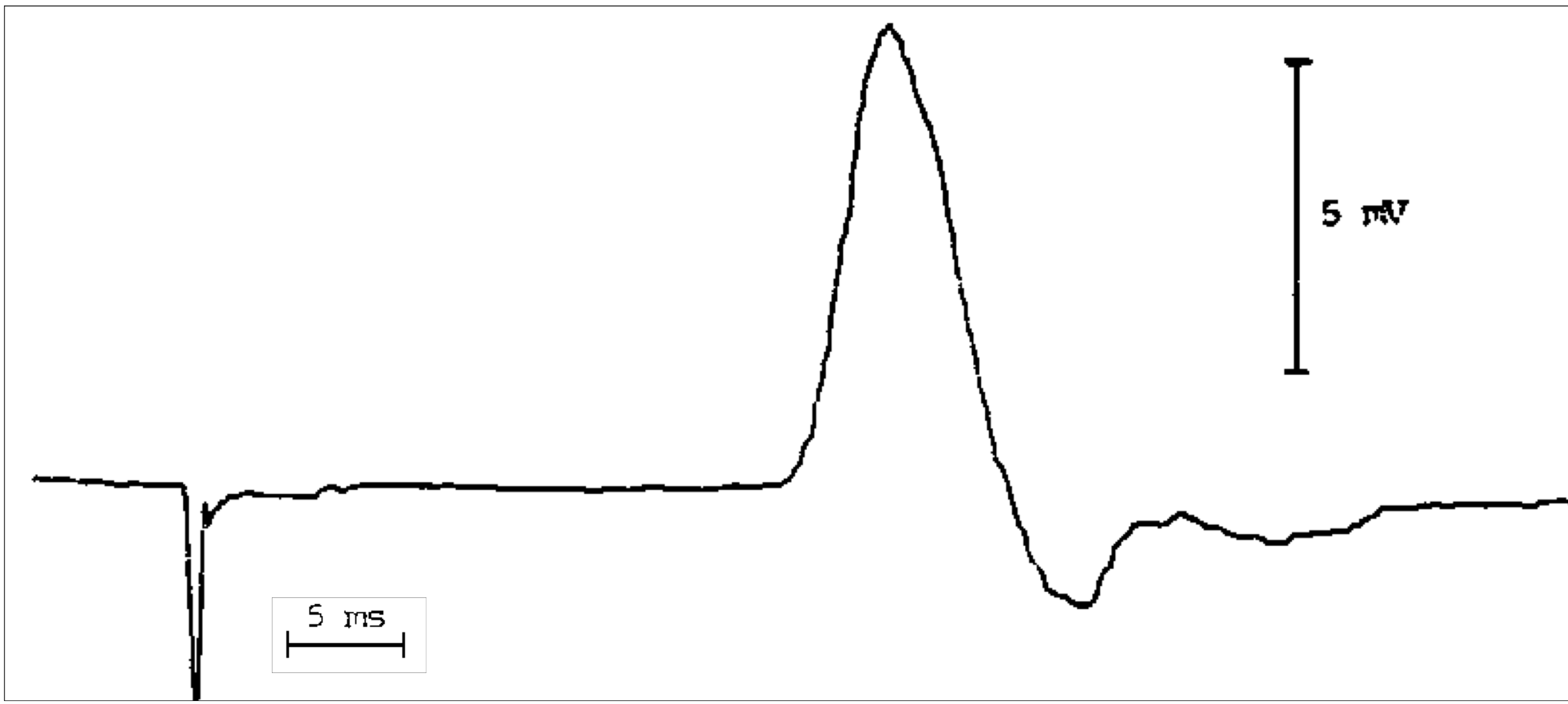
Noninvasive Brain Stimulation

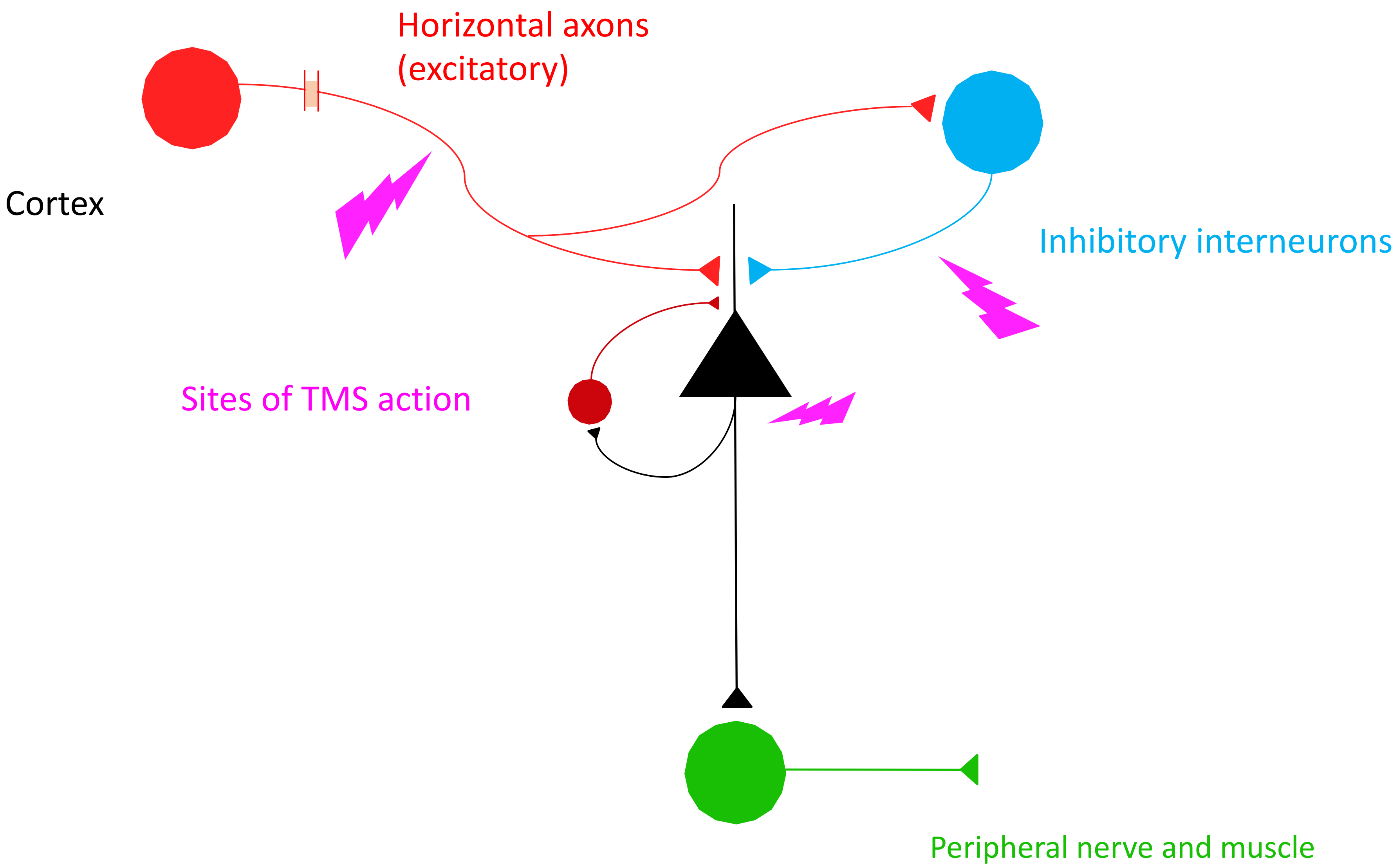
Does it work?


Na

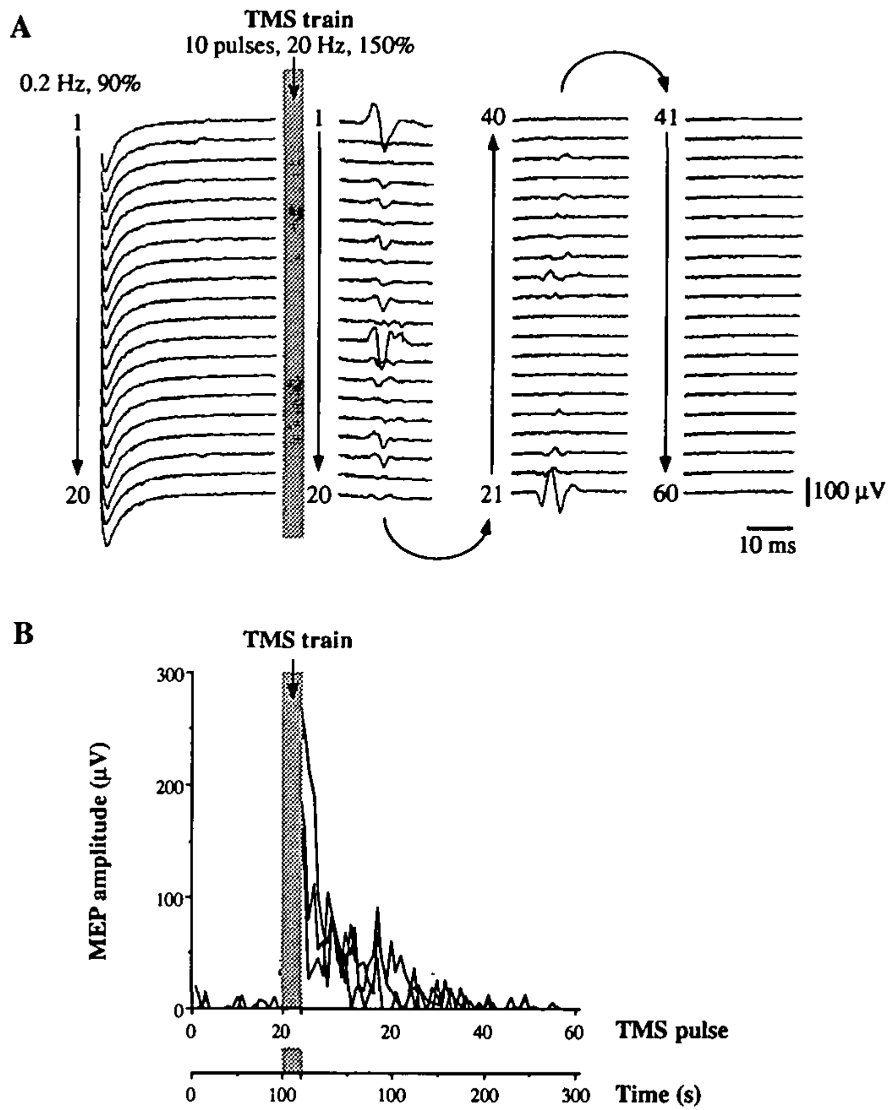
Motor evoked potential (MEP)



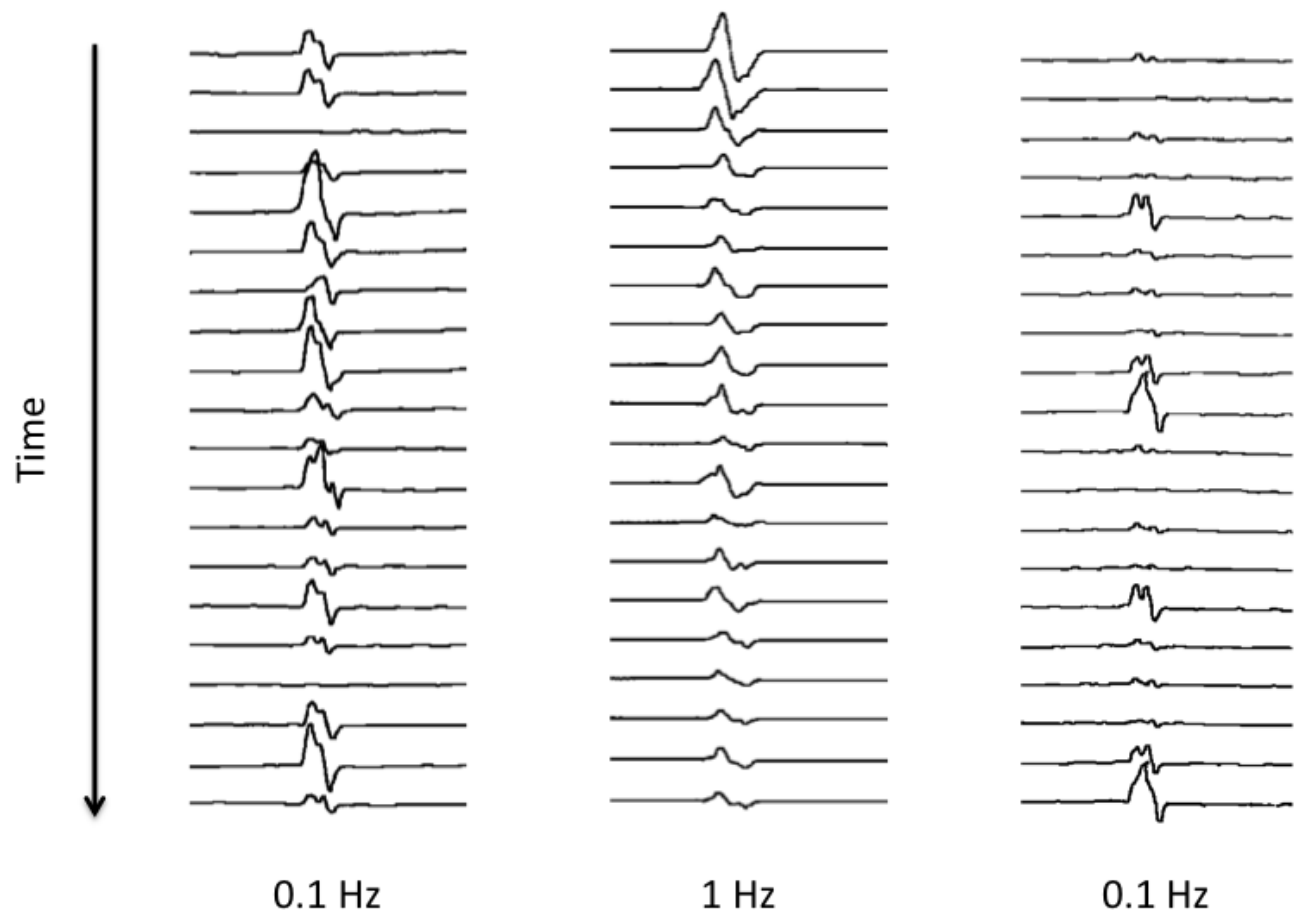
Simplified schema for TMS action in the motor cortex



Increased excitability after high-frequency rTMS



Effect of 1 Hz rTMS on M1 excitability



PLOS ONE

RESEARCH ARTICLE

The Use and Abuse of Transcranial Magnetic Stimulation to Modulate Corticospinal Excitability in Humans

Martin E. Héroux[1,2], Janet L. Taylor[1,2], Simon C. Gandevia[1,2]*

1 Neuroscience Research Australia, Randwick, NSW, Australia, **2** University of New South Wales, Randwick, NSW, Australia

File drawer papers:	144/153
Formal power calculations	20%
Added subjects after setting sample size	15%

Found effects as reported	
Continuous theta burst TMS	45%
Intermittent theta burst TMS	45%
Low frequency TMS	60%
High frequency TMS	59%

No effect of years of experience

PLOS | ONE

RESEARCH ARTICLE

The Use and Abuse of Transcranial Magnetic Stimulation to Modulate Corticospinal Excitability in Humans

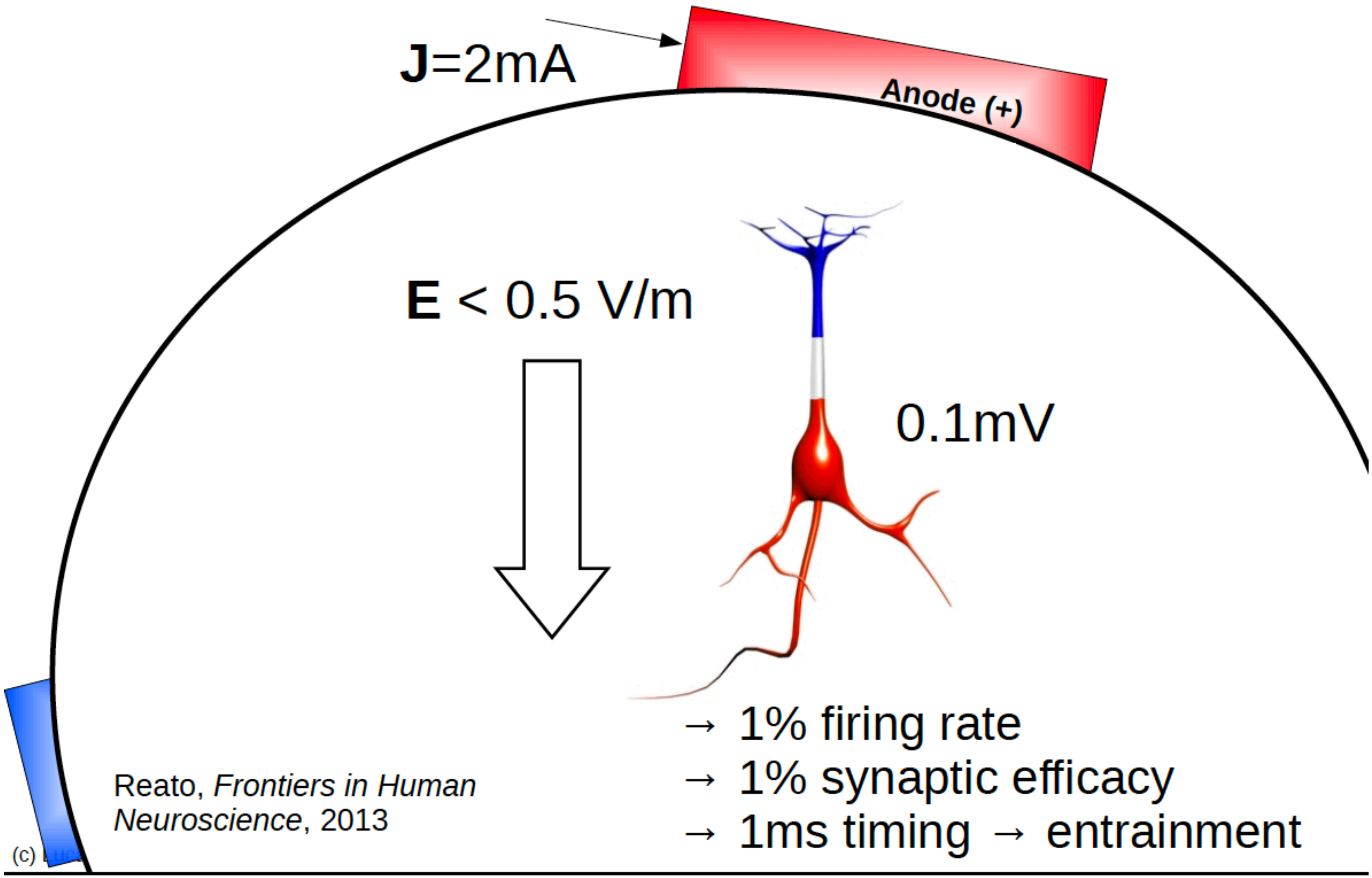
Martin E. Héroux[1,2], **Janet L. Taylor**[1,2], **Simon C. Gandevia**[1,2]*

1 Neuroscience Research Australia, Randwick, NSW, Australia, **2** University of New South Wales, Randwick, NSW, Australia

Table 1. Prevalence of questionable research practices.

Questionable research practices	Others [count(%)]	Self [count(%)]
Screen for 'responders' to a TMS protocol	38 (68)	18 (38)
Drop data points based on a gut feeling	18 (38)	6 (13)
Exclude data after looking at impact on results	14 (30)	3 (6)
Not report all experimental conditions	19 (40)	10 (21)
Selectively report outcomes	23 (49)	5 (11)
Selectively report time points	14 (30)	5 (11)
Selectively report sub-groups of subjects	18 (38)	8 (17)
Reject 'outliers' without statistical support	19 (30)	10 (21)

Transient effects – summary

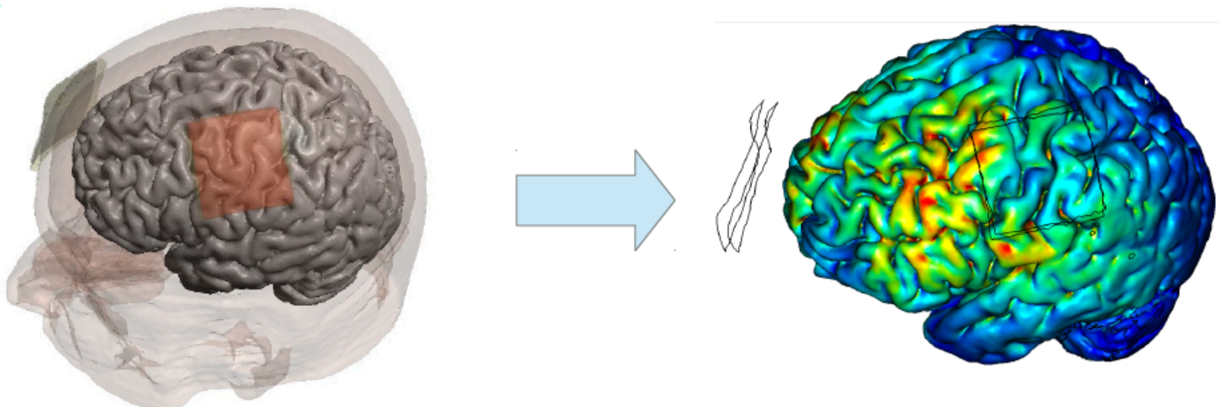


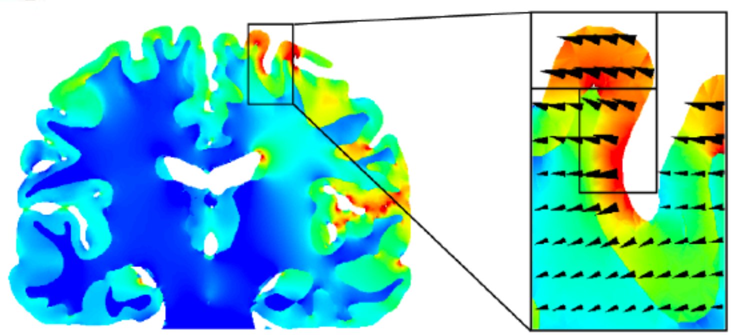
Reato, *Frontiers in Human Neuroscience*, 2013

→ 1% firing rate
→ 1% synaptic efficacy
→ 1ms timing → entrainment

Detailed models of current flow

Marom Bikson





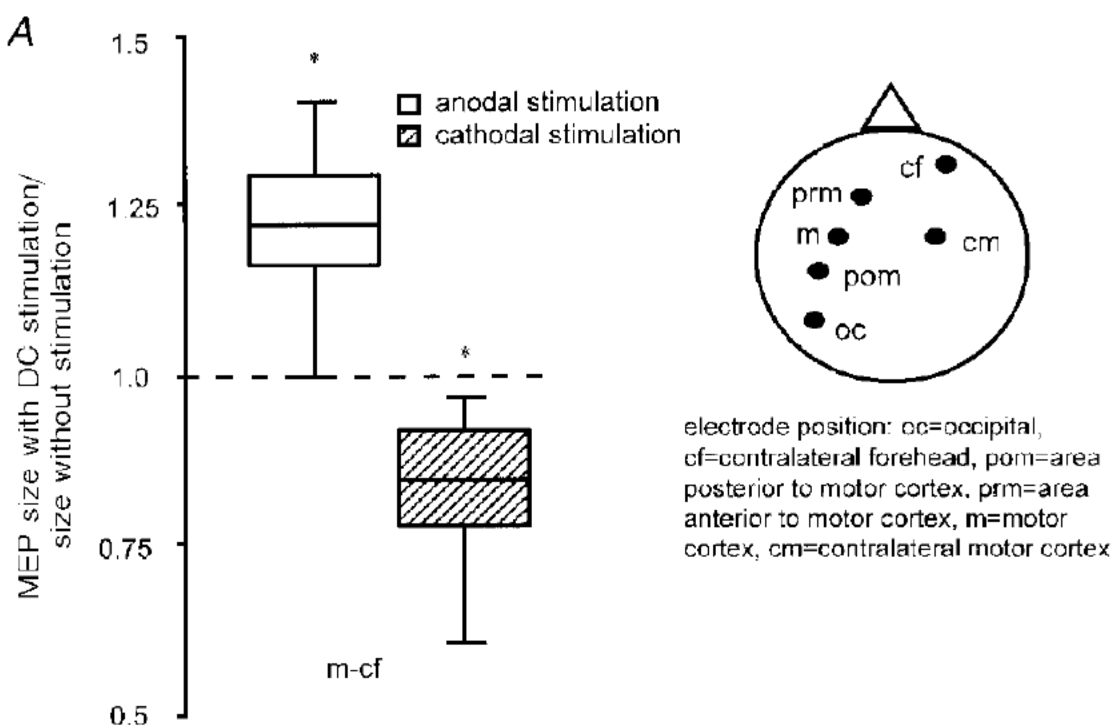
- Maximum not always under the electrode
- Polarity inevitably mixed

Datta, *Brain Stimulation*, 2009
Rahman, J Physiology, 2013

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

M. A. Nitsche and W. Paulus

Department of Clinical Neurophysiology, University of Goettingen, Robert Koch Strasse 40, 37075 Goettingen, Germany



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]

[1]Dipartimento di Scienze Neurologiche, Università degli Studi di Roma 'La Sapienza', 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

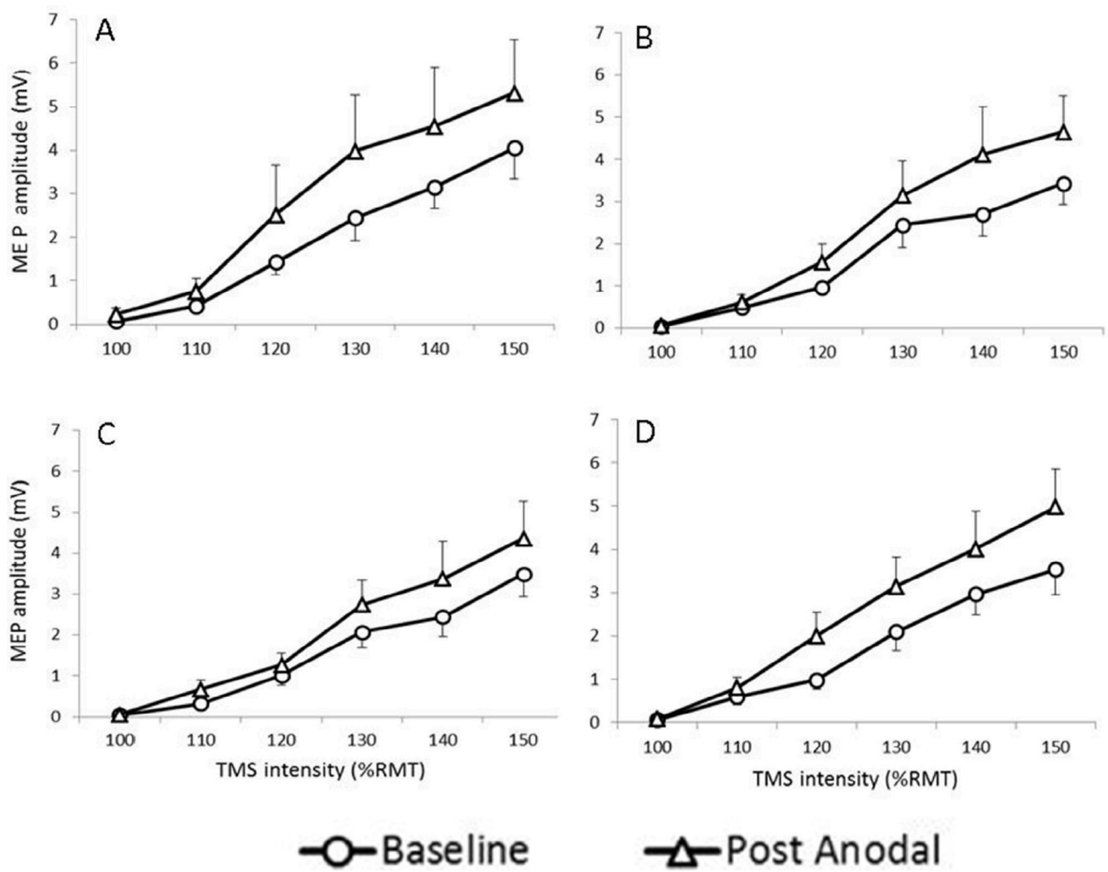
Contents lists available at ScienceDirect

Brain Stimulation

journal homepage: www.brainstimjrnl.com

Intra-Subject Consistency and Reliability of Response Following 2 mA Transcranial Direct Current Stimulation

Katherine Dyke [a], Soyoung Kim [a], Georgina M. Jackson [b], Stephen R. Jackson [a,*]



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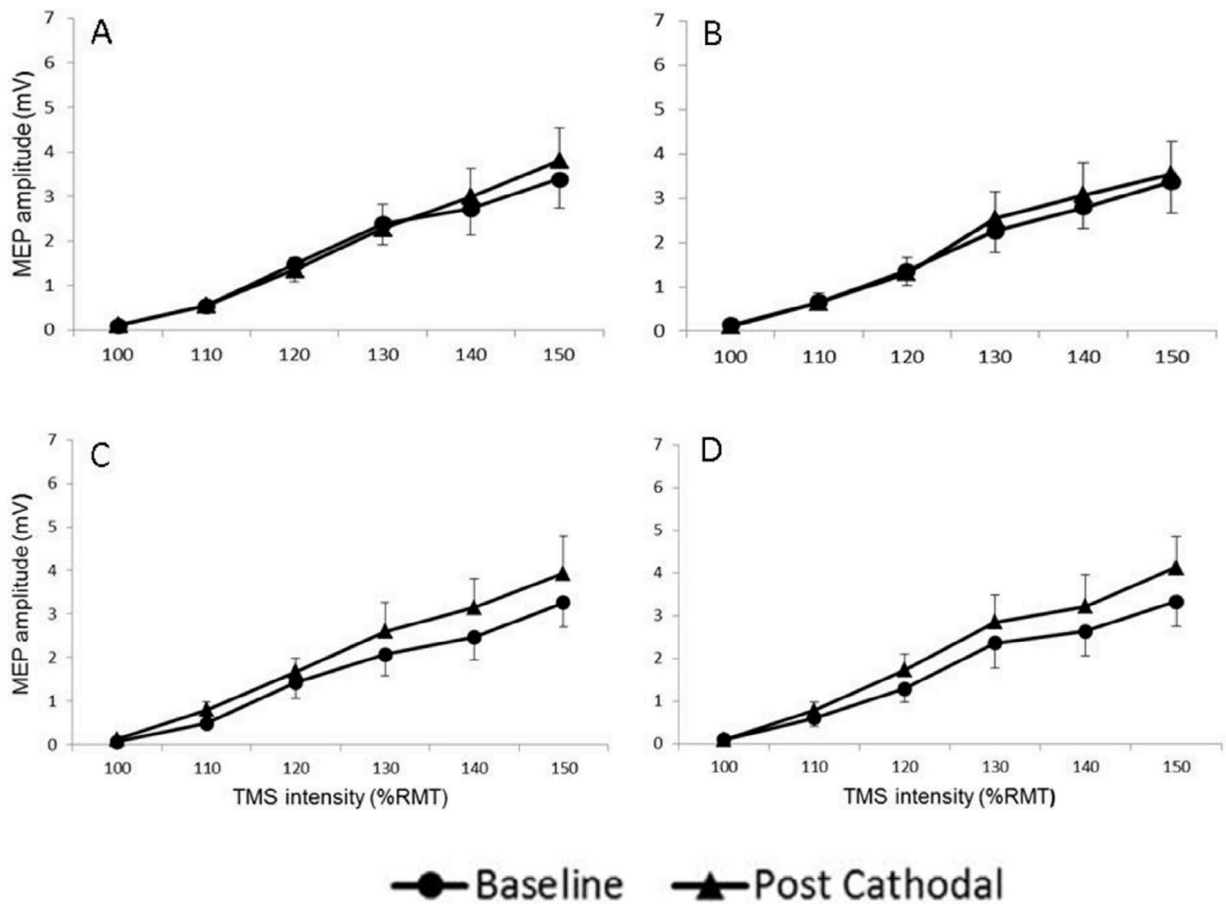
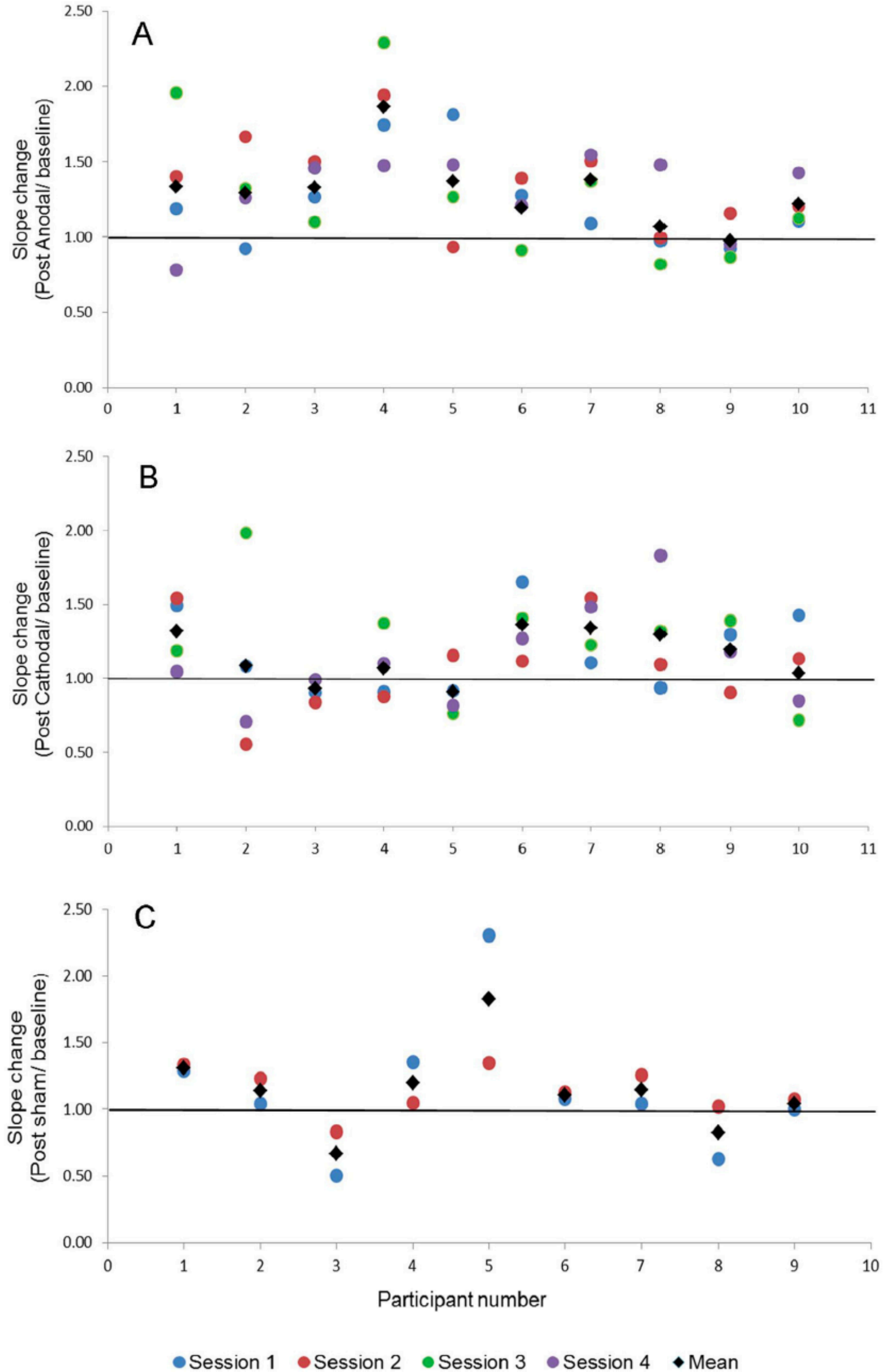




A
B
C
Slope change (Post Anodal/ baseline)
Slope change (Post Cathodal/ baseline)
Slope change (Post sham/ baseline)
Participant number
2.50
2.00
1.50
1.00
0.50
0.00
0
1
2
3
4
5
6
7
8
9
10
11
Session 1
Session 2
Session 3
Session 4
Mean

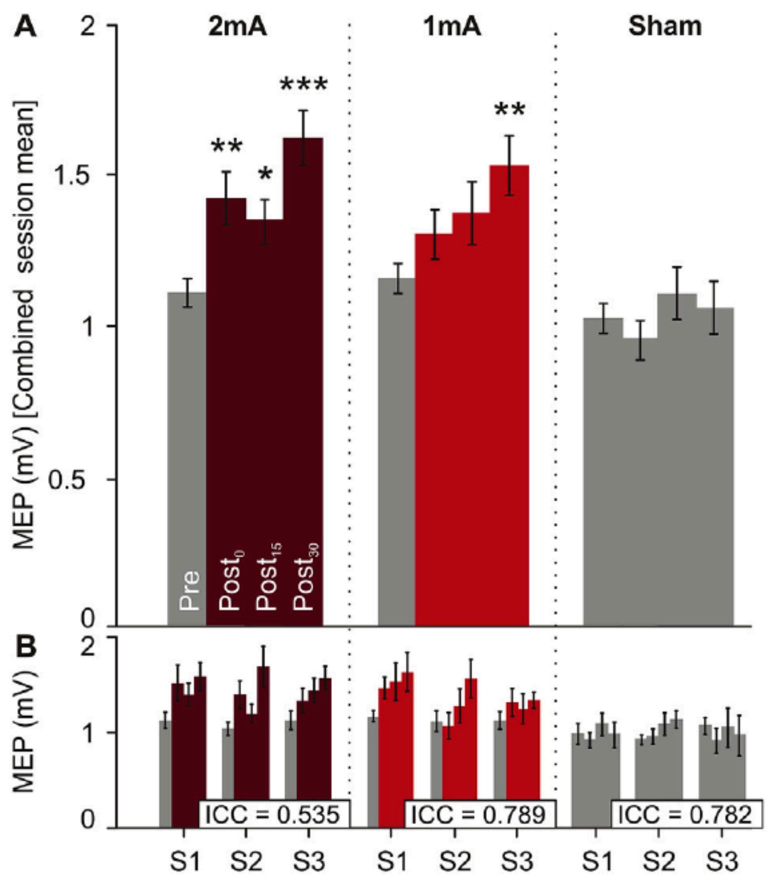
Contents lists available at ScienceDirect

Brain Stimulation

journal homepage: http://www.journals.elsevier.com/brain-stimulation

Response variability of different anodal transcranial direct current stimulation intensities across multiple sessions

Claudia Ammann [a], Martin A. Lindquist [b], Pablo A. Celnik [a,*]



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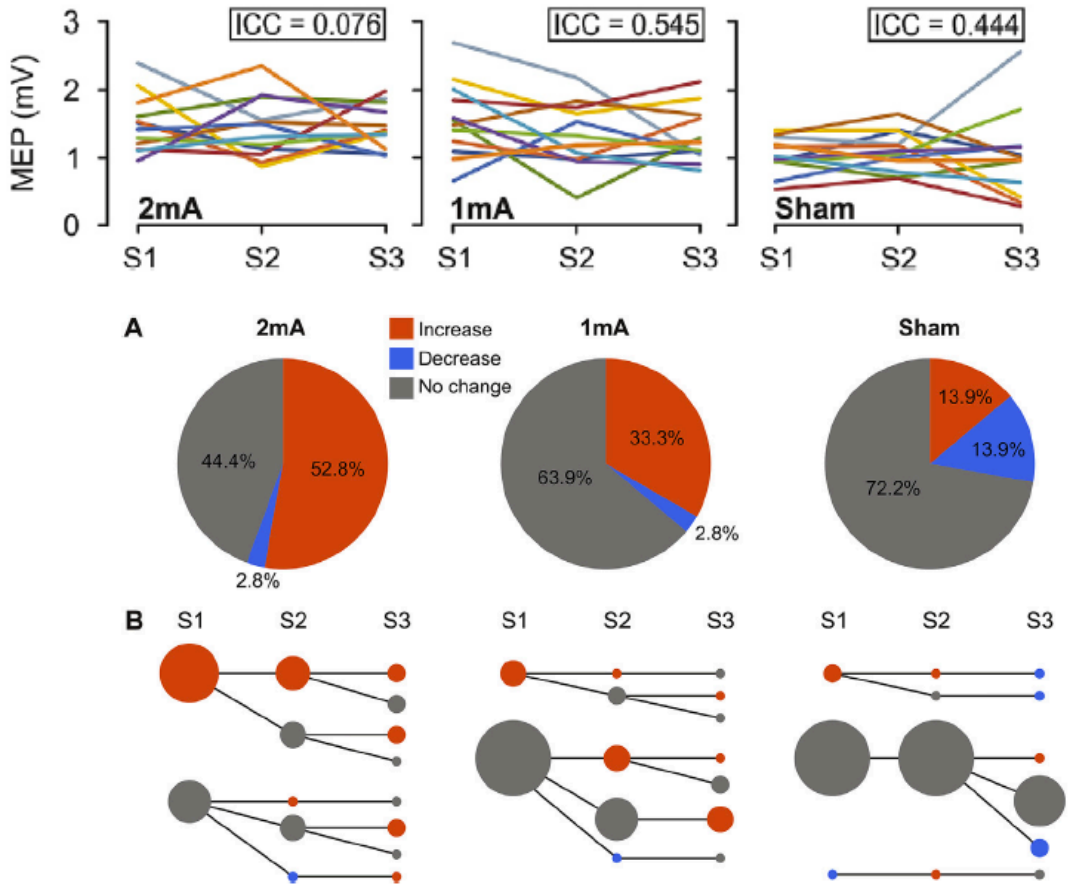

RESEARCH ARTICLE

Questionable science and reproducibility in electrical brain stimulation research

Martin E. Héroux[1,2], **Colleen K. Loo**[3,4,5], **Janet L. Taylor**[1,2], **Simon C. Gandevia**[1,2,6]*

1 Neuroscience Research Australia, Randwick, NSW, Australia, **2** School of Medical Sciences, University of New South Wale, Sydney, NSW, Australia, **3** School of Psychiatry, University of New South Wales, Sydney, NSW, Australia, **4** Black Dog Institute, University of New South Wales Sydney, NSW, Australia, **5** Department of Psychiatry, St. George Hospital, Sydney, NSW, Australia, **6** Prince of Wales Clinical School, University of New South Wales, Sydney, NSW, Australia

Table 2. Sample size determination.

	Total studies (n [%]) *	Respondents (%) †	Audit papers (%) ‡
Power calculation	426 [26]	61	6
Pilot data	126 [8]	32	1
Sample size from published paper	403 [25]	69	0
Personal experience	364 [22]	38	0
How data are looking	74 [5]	14	0
Stop study early—no effect	55 [3]	11	0
Stop study early—effect	21 [1]	5	0
Allow more samples to be collected	130 [8]	24	0
No strategy	41 [3]	11	93

PLOS | ONE

RESEARCH ARTICLE

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Table 3. Prevalence of questionable research practices.

Questionable research practices	Others (%)	Self (%)	Audit (%)
Adjust statistical analyses in order to optimise the results	43	25	0
Not report all experimental conditions	36	13	0
Screen whether subjects are responders and not report it	21	4	0
Exclude data based on a gut feeling	21	8	0
Exclude data after looking at impact on results	20	9	0
Exclude trials or subjects without support of statistical analysis	22	8	2
Selectively report outcomes	41	14	0
Selectively report time points	18	3	0
Selectively report types of EBS used in study	12	4	0
Selectively report sub-groups of subjects	24	14	0

Contents lists available at ScienceDirect

Brain Stimulation

journal homepage: www.brainstimjrnl.com

Quantitative Review Finds No Evidence of Cognitive Effects in Healthy Populations From Single-session Transcranial Direct Current Stimulation (tDCS)

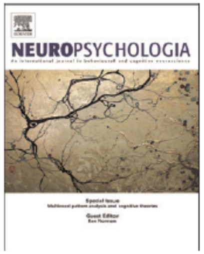
Jared Cooney Horvath*, Jason D. Forte, Olivia Carter

University of Melbourne, Melbourne School of Psychological Sciences, Redmond Barry Building, Melbourne, VIC 3010, Australia

Contents lists available at ScienceDirect

Neuropsychologia

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



Reviews and perspectives

Evidence that transcranial direct current stimulation (tDCS) generates little-to-no reliable neurophysiologic effect beyond MEP amplitude modulation in healthy human subjects: A systematic review

Jared Cooney Horvath*, Jason D. Forte, Olivia Carter

University of Melbourne, School of Psychological Sciences, Melbourne, VIC, Australia

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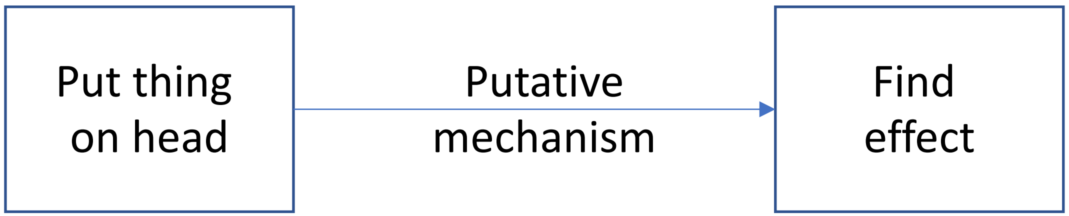
Brain Stimulation

journal homepage: http://www.journals.elsevier.com/brain-stimulation

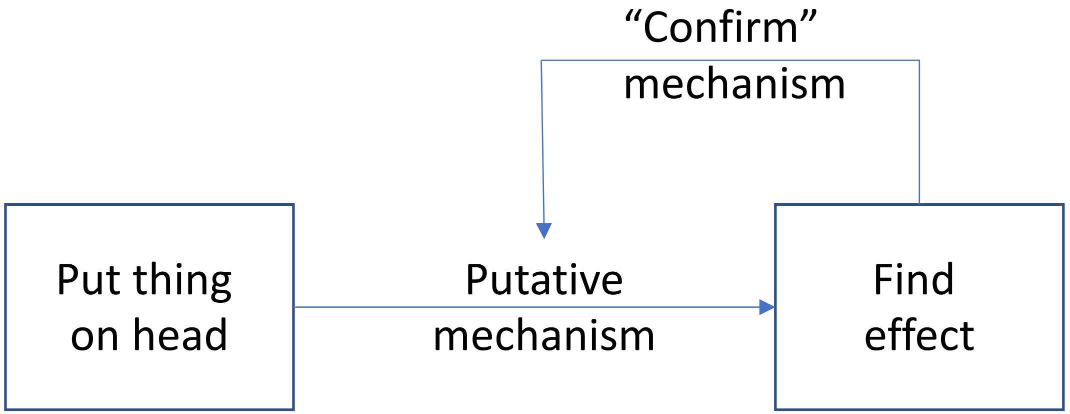
Rigor and reproducibility in research with transcranial electrical stimulation: An NIMH-sponsored workshop

Marom Bikson [a], Andre R. Brunoni [b], Leigh E. Charvet [c], Vincent P. Clark [d], Leonardo G. Cohen [e], Zhi-De Deng [f], Jacek Dmochowski [a], Dylan J. Edwards [g], Flavio Frohlich [h], Emily S. Kappenman [i], Kelvin O. Lim [j], Colleen Loo [k], Antonio Mantovani [l], David P. McMullen [m], Lucas C. Parra [a], Michele Pearson [m], Jessica D. Richardson [n], Judith M. Rumsey [m, *], Pejman Sehatpour [o], David Sommers [p], Gozde Unal [a], Eric M. Wassermann [q], Adam J. Woods [r], Sarah H. Lisanby [m, 1]

The problem

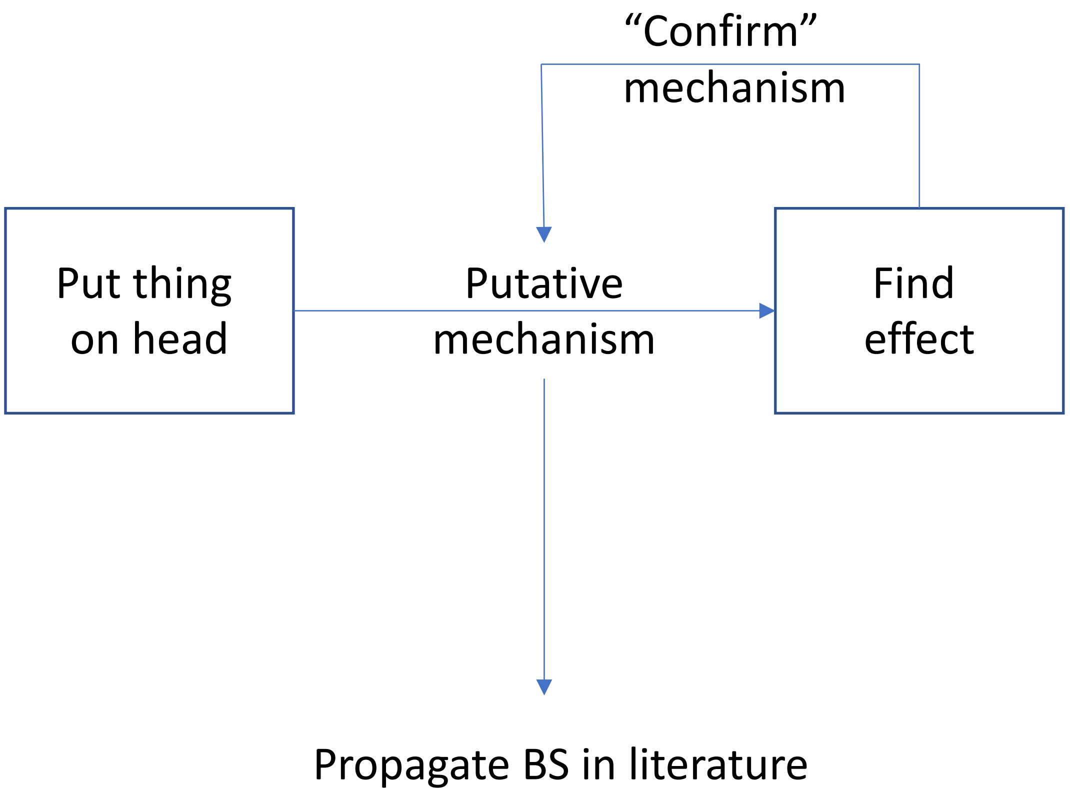


The problem



“Confirm”
mechanism
Put thing
on head
Putative
mechanism
Find
effect

The problem


"Confirm"
mechanism
Put thing
on head
Putative
mechanism
Find
effect
Propagate BS in literature

Shifts in connectivity during procedural learning after motor cortex stimulation: A combined transcranial magnetic stimulation/functional magnetic resonance imaging study

Adam Steel [a], Sunbin Song [b], Devin Bageac [a], Kristine M. Knutson [a], Aysha Keisler [a], Ziad S. Saad [c], Stephen J. Gotts [d], Eric M. Wassermann [a,] and Leonora Wilkinson [a]*

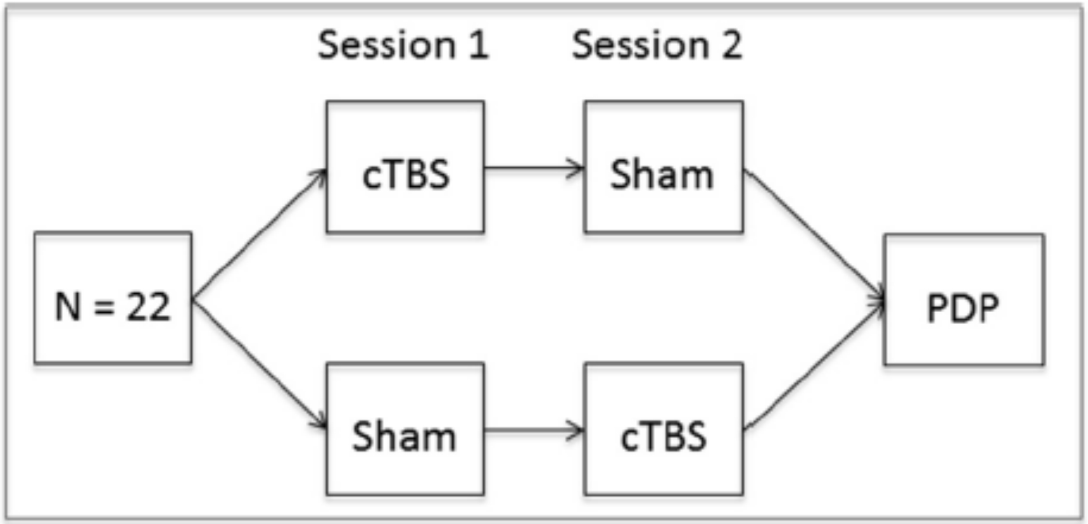
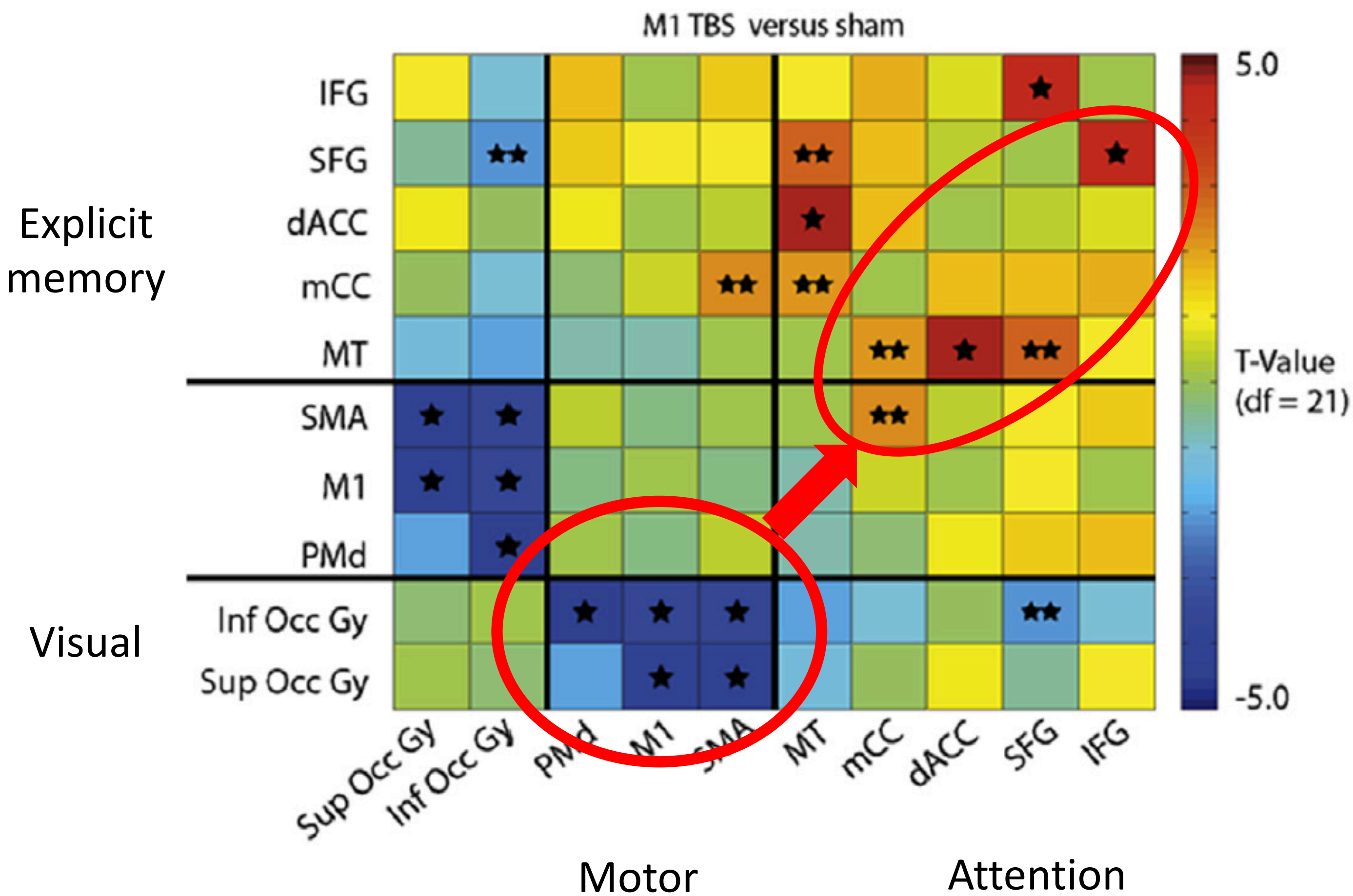


Fig. 1 – Experimental design. Each participant underwent two TBS-fMRI sessions, during which they received either real or sham cTBS over M1. The order of stimulation conditions was counterbalanced. Experimental sessions occurred at least one week apart.

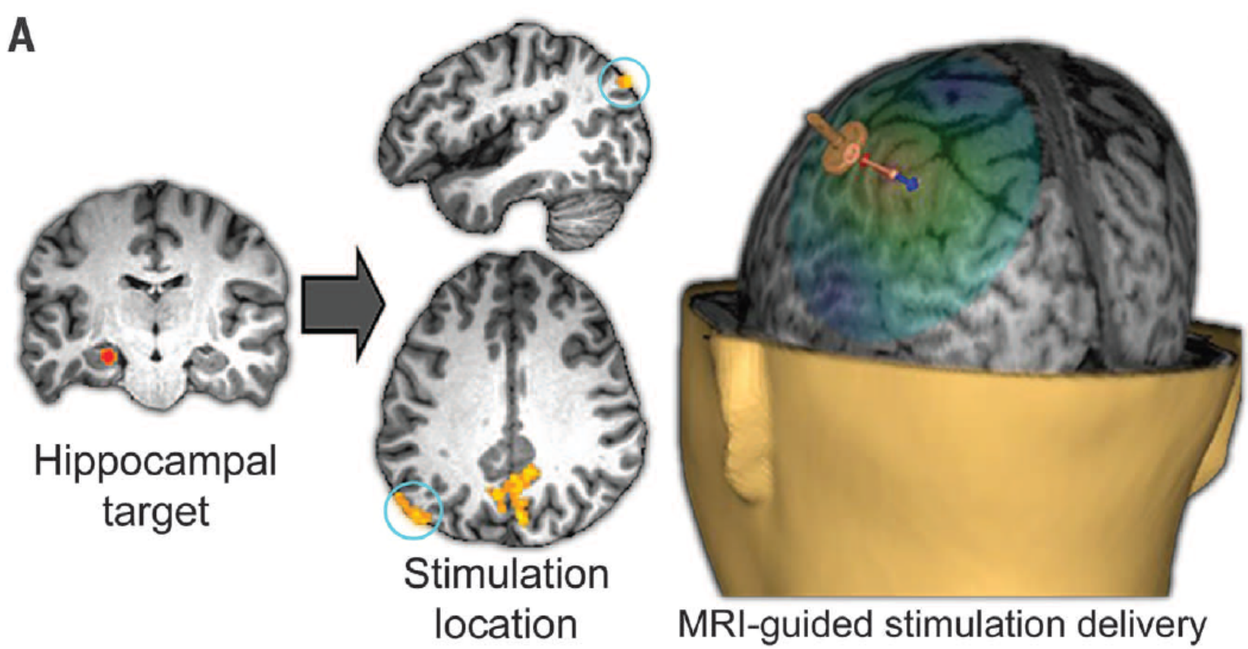


M1 TBS versus sham
Explicit memory
Visual
Motor
Attention
IFG
SFG
dACC
mCC
MT
SMA
M1
PMd
Inf Occ Gy
Sup Occ Gy
Sup Occ Gy
Inf Occ Gy
PMd
M1
SMA
MT
mCC
dACC
SFG
IFG
5.0
T-Value (df = 21)
-5.0

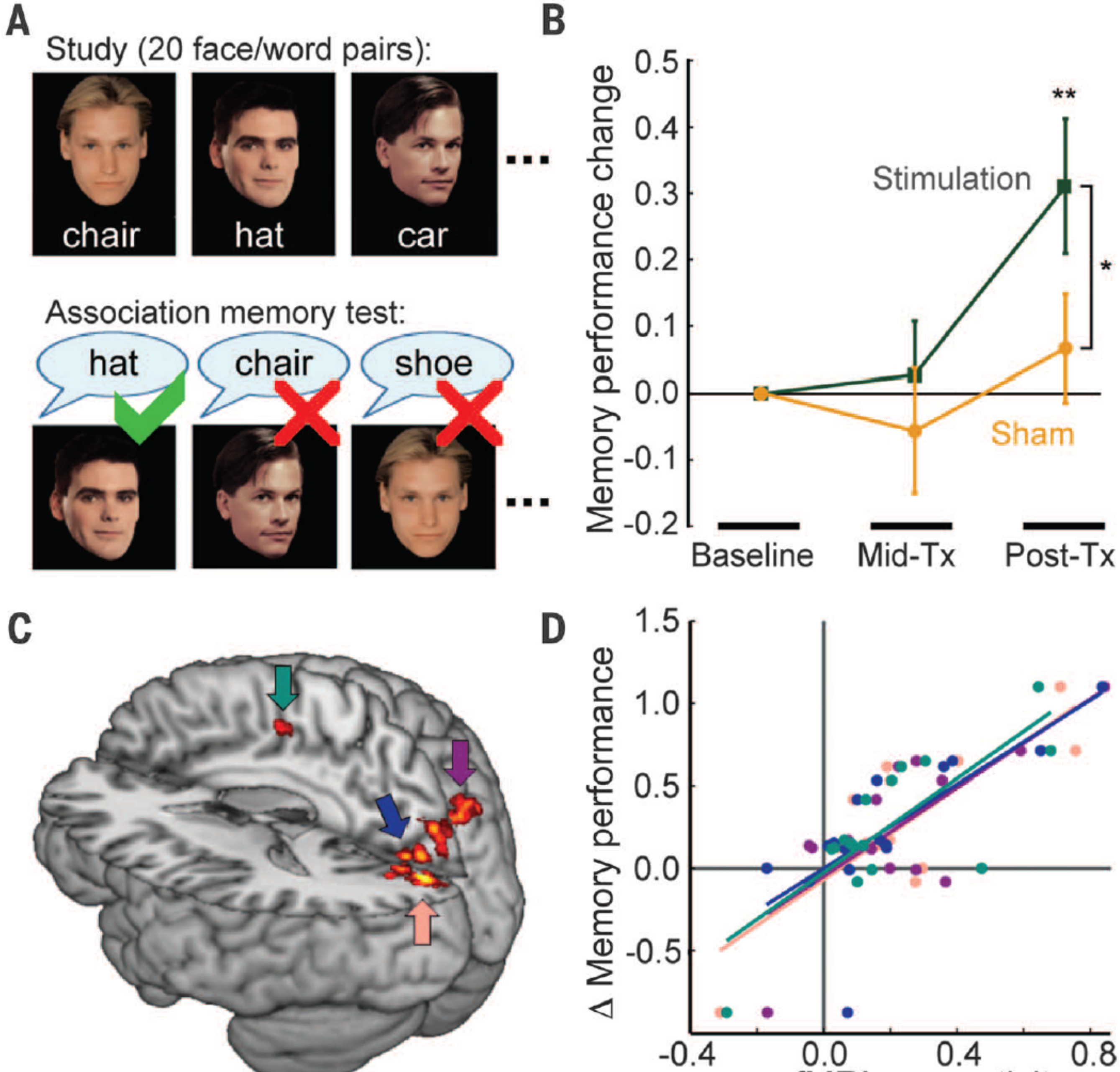
MEMORY ENHANCEMENT

Targeted enhancement of cortical-hippocampal brain networks and associative memory

Jane X. Wang,[1] Lynn M. Rogers,[2] Evan Z. Gross,[1] Anthony J. Ryals,[1] Mehmet E. Dokucu,[3] Kelly L. Brandstatt,[1] Molly S. Hermiller,[1] Joel L. Voss[1*]



Science 2014 345:1054



Science 2014 345:1054

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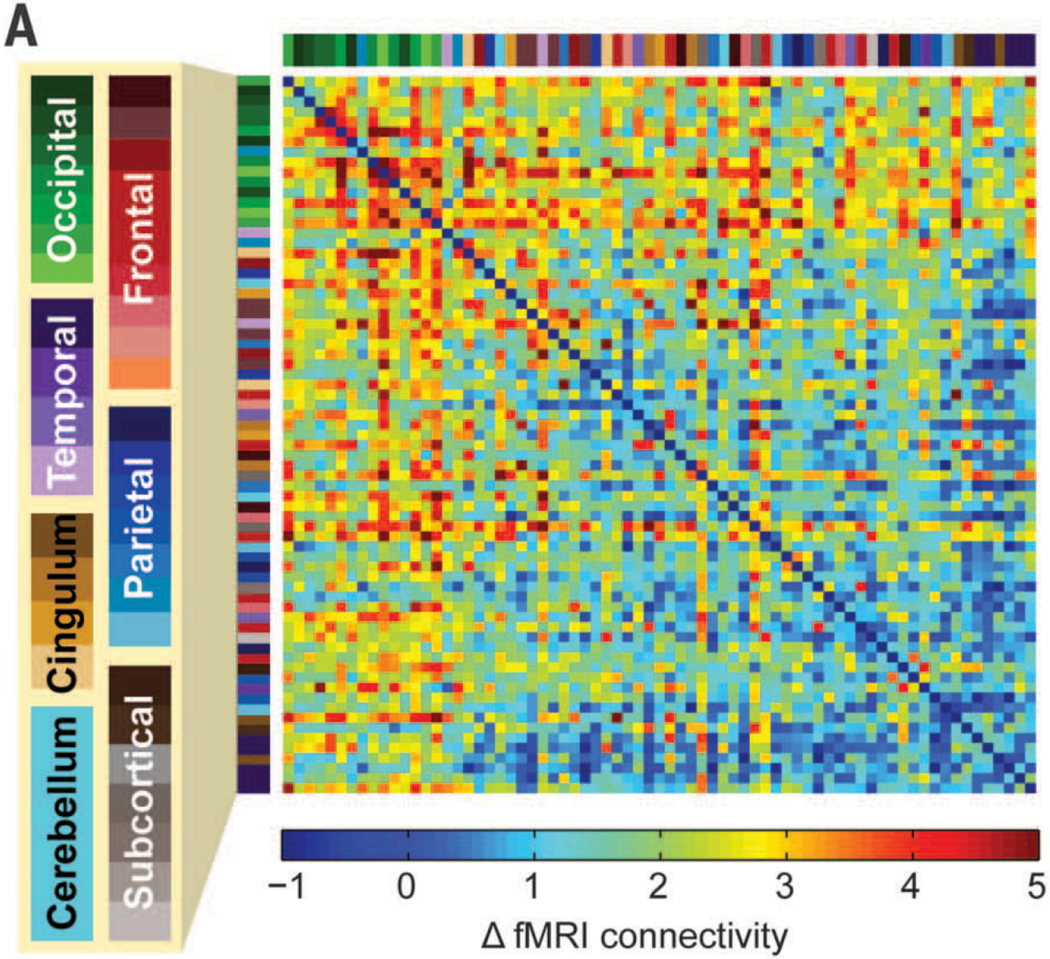
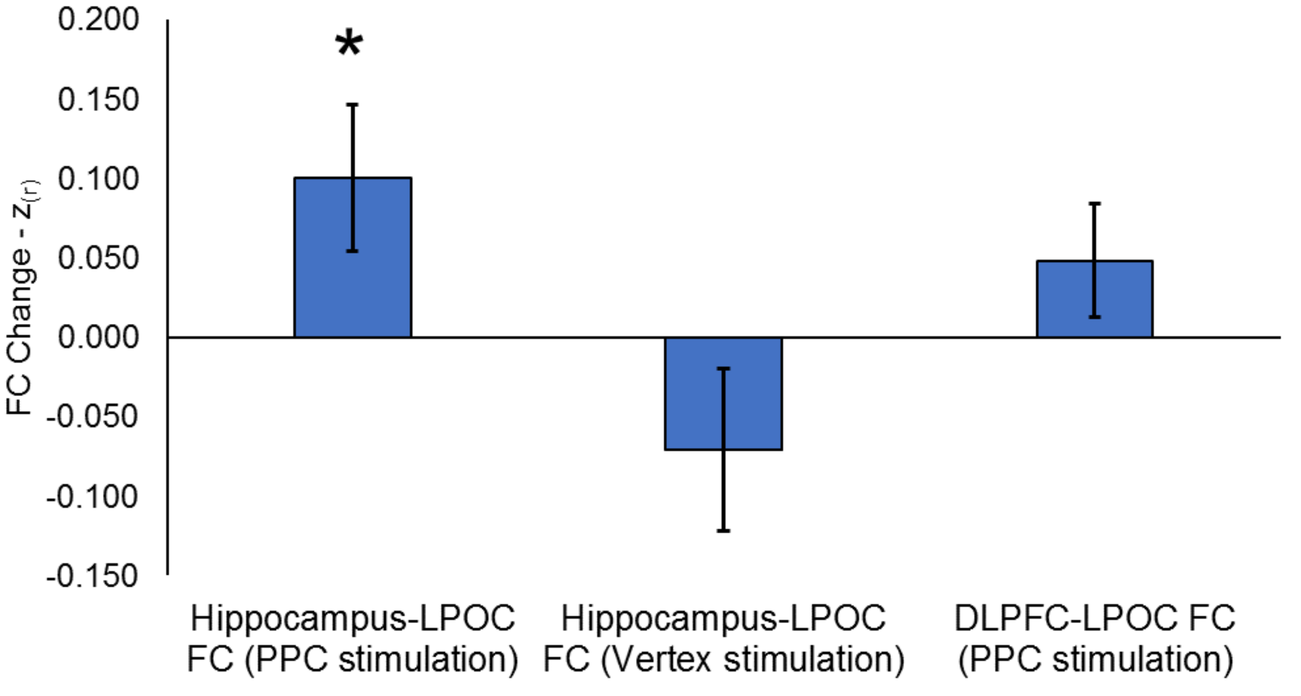
A



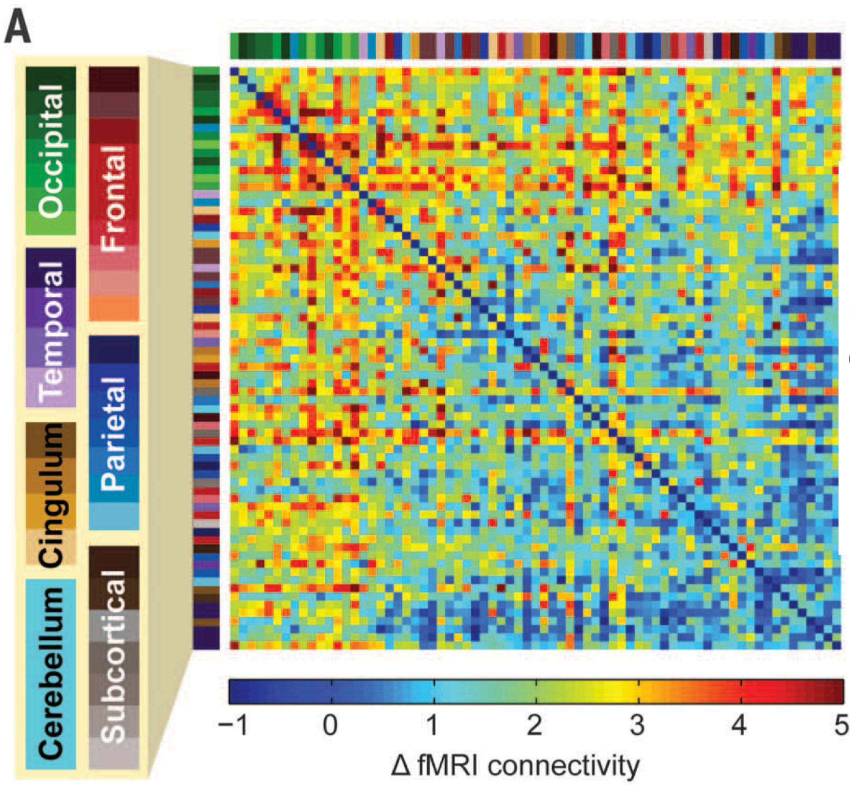
Reproduction



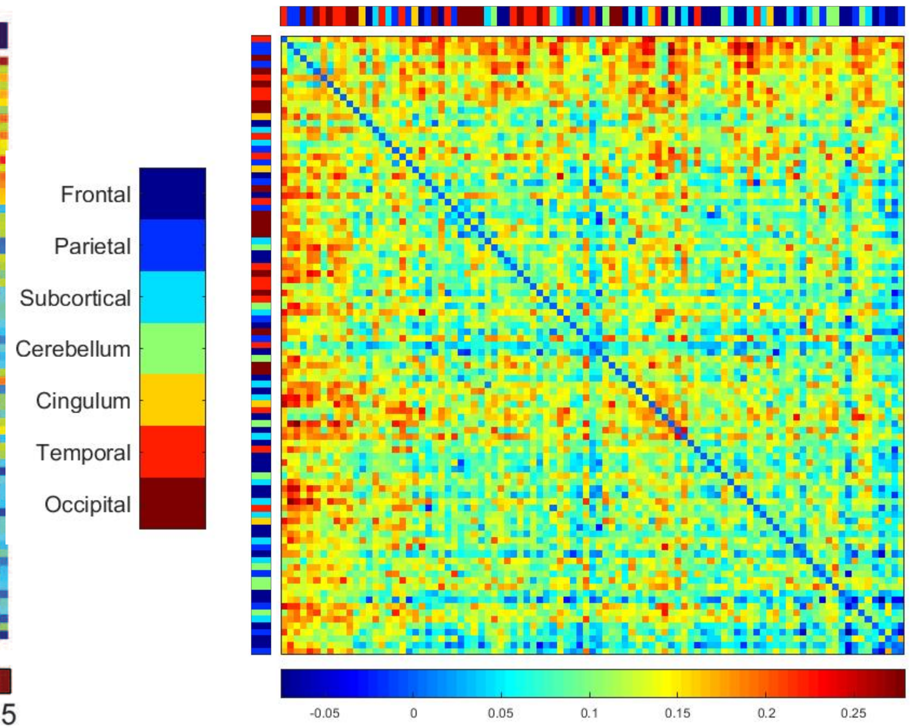
* - $p < 0.05$

Baseline Hippocampal FC predicts change in FC

Wang



Freedberg



Depends