UNIVERSITY OF MINNESOTA
Driven to Discover℠
MEDICAL DISCOVERY TEAM ON ADDICTION

UNIVERSITY OF MINNESOTA
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LIBR
Laureate Institute for Brain Research

La neuromodulation dans le traitement des addictions :

données actuelles et perspectives d'avenir

Neuromodulation for Addiction Treatment: Current Evidence and Future Perspective

SCAN ME

17e Congrès International
d'Addictologie de l'ALBATROS
17th ALBATROS International Congress of Addictology

CONGRÈS ALBATROS

Hamed Ekhtiari, MD, PhD

Department of Psychiatry and Behavioral Sciences, University of Minnesota

Center for Neural Circuits in Addiction, Department of Neuroscience, University of Minnesota

Do We Have Any FDA (ANSM/HAS) Approved Brain Stimulation Treatment for **Addiction**?

How Many Clinical Approvals We Have for Brain Stimulation in **Psychiatry**?

Disclosure of Conflict of Interest:

None!

Funding:

Warren Family Foundation, NARSAD, OCAST, Medical Discovery Team for Addiction (MDTA)

UNIVERSITY OF MINNESOTA
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LIBR

Martin Paulus

Robin Aupperle

Rayus Kuplicki

Jerzy Bodurka (RIP)

Yoon-Hee Cha

WIR

Family & Children's SERVICES

Life Changing.

12 & 12 INCORPORATED

THE UNIVERSITY of TULSA

Laureate Psychiatric Clinic and Hospital

A part of Saint Francis Health System

LADURÉE
Paris

Craving (Cue Induced)

0 10 20 30 40 50 60 70 80 90 100

LADURÉE
Paris

Craving (Cue Induced)

0 10 20 30 40 50 60 70 80 90 100

Craving (Cue Induced)

JAMA Psychiatry | Original Investigation

Association of Drug Cues and Craving With Drug Use and Relapse
A Systematic Review and Meta-analysis

Nilofar Vafaie, MS; Hedy Kober, PhD

CONCLUSIONS AND RELEVANCE Findings from this systematic review and meta-analysis suggest that drug cue and craving indicators play significant roles in drug use and relapse outcomes and are an important mechanism underlying SUDs. Clinically, these results support incorporating craving assessment across stages of treatment, as early as primary care.

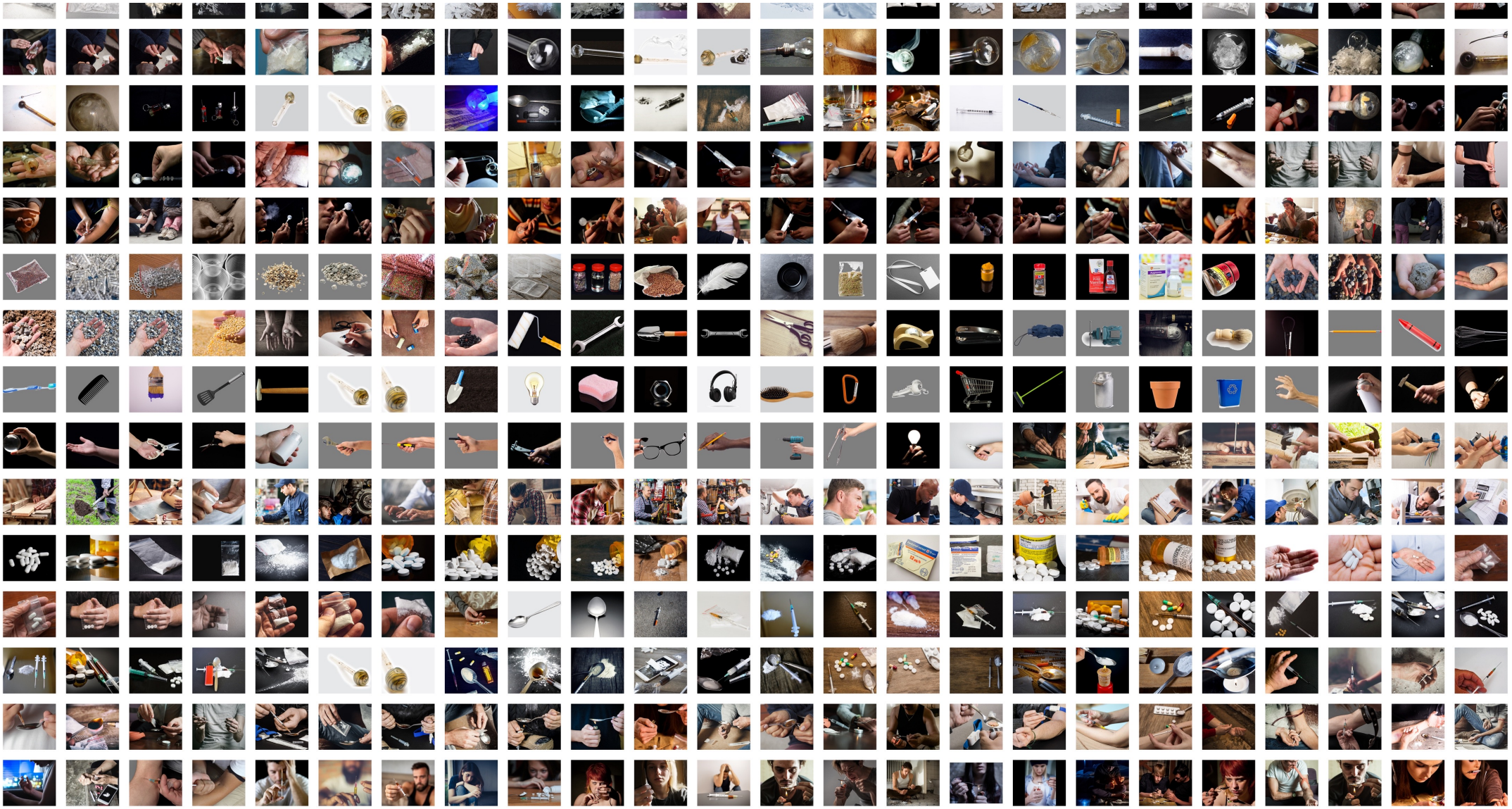
JAMA Psychiatry. doi:10.1001/jamapsychiatry.2022.1240
Published online June 1, 2022.

Drug and Alcohol Dependence
Volume 209, 1 April 2020, 107941

Full length article

Methamphetamine and Opioid Cue Database (MOCD): Development and Validation

Hamed Ekhtiari [a], Rayus Kuplicki [a], Asheema Pruthi [a b], Martin Paulus [a]

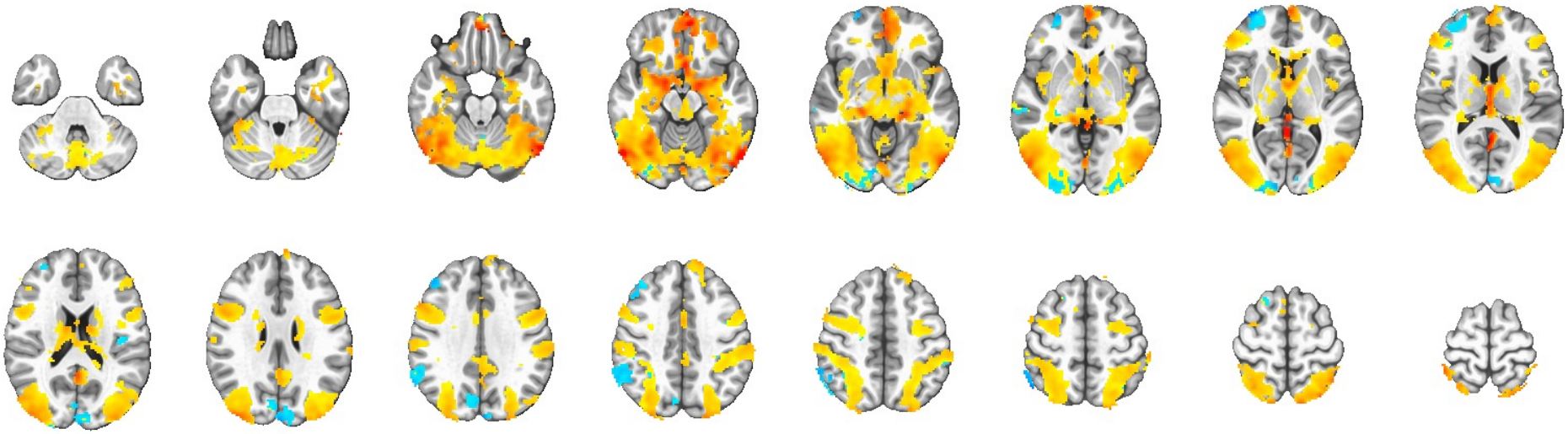


Methamphetamine and Opioid Cue Database (MOCD)

Drug and Alcohol Dependence 209 (2020) 107941

Drug > Neutral

Brain Response to Drug Cues (Cue Reactivity)



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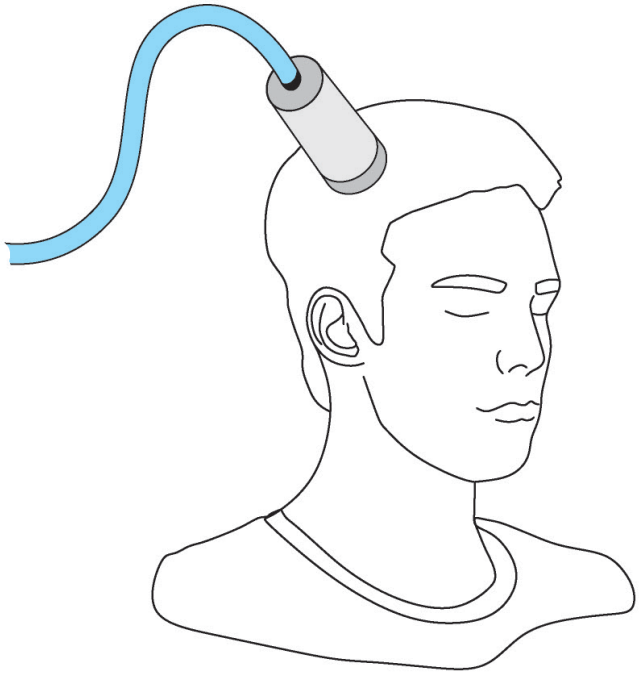
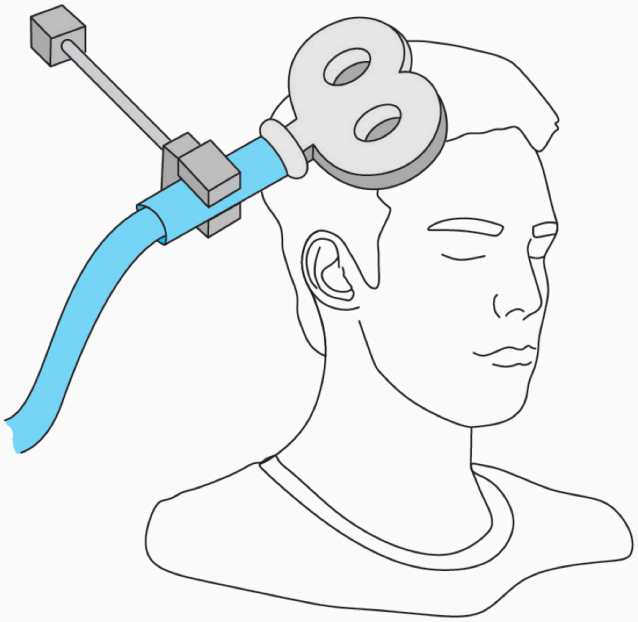
-2.93 β 2.93

(Ekhtiari, et al., 2021)

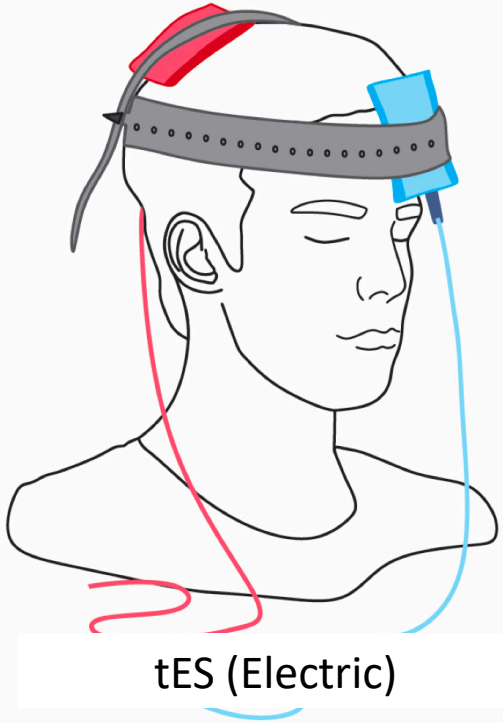
Non-Invasive Brain Stimulation (NIBS) Interventions



tUS (Ultrasound)

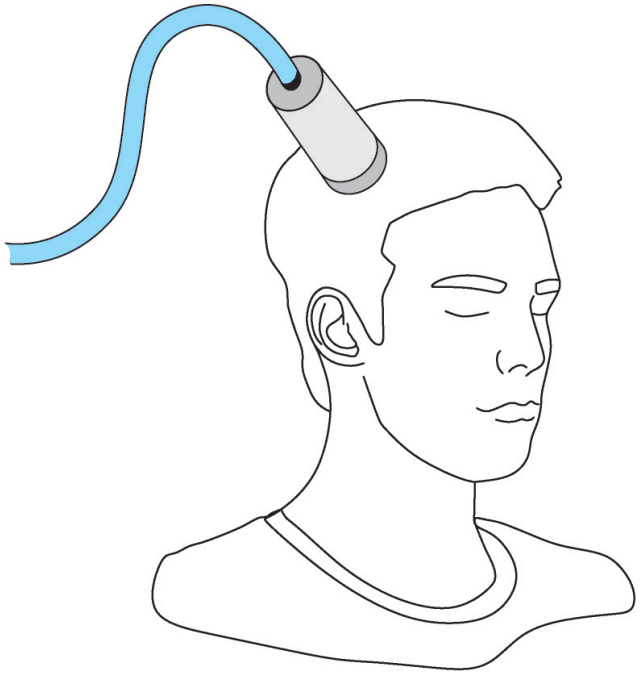


TMS (Magnetic)



tES (Electric)

Where to Target with Brain Stimulation Interventions?



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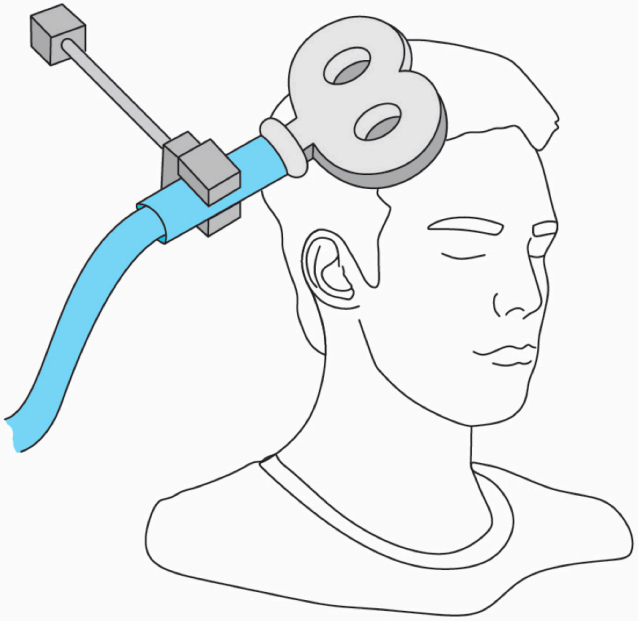

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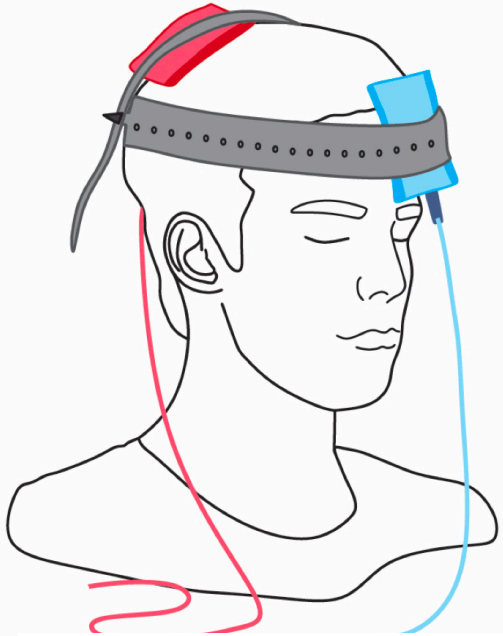


tES (Electric)

Where to Target with Brain Stimulation Interventions?

nature medicine

ARTICLES

https://doi.org/10.1038/s41591-022-01834-y

Check for updates

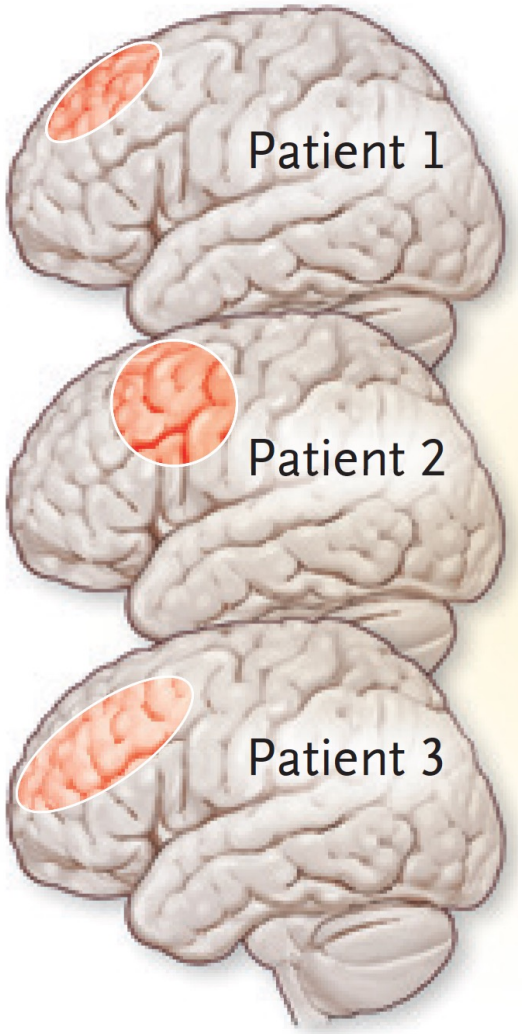
OPEN

Brain lesions disrupting addiction map to a common human brain circuit

Juho Joutsa[1,2,3,17] ✉, Khaled Moussawi[4,5,17], Shan H. Siddiqi[3,6,17], Amir Abdolahi[7], Willia
Alexander L. Cohen[3,6,8,9], Thomas J. Ross[4], Harshawardhan U. Deshpande[4], Henry
Joel Bruss[11], Elliot A. Stein[4], Nora D. Volkow[16], Jordan H. Grafman[12,13,14], Edwin van Wi
Aaron D. Boes[11] and Michael D. Fox[3,6] ✉

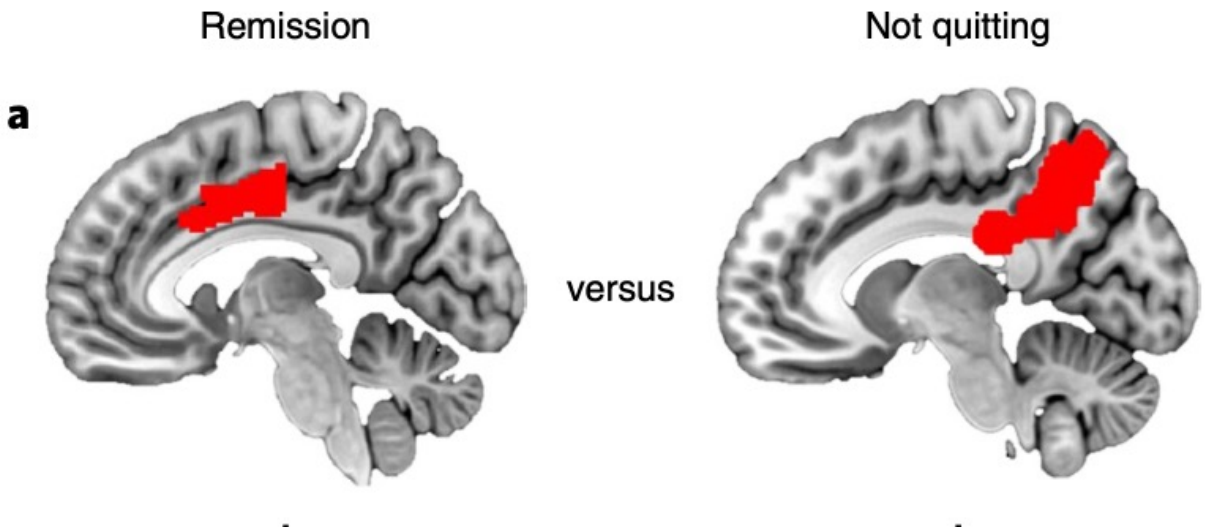
Michael Fox
Harvard Medical School
USA

Overlap in Lesion Location across Patients with the Same Symptom



Brain Lesions in People Who Stopped Smoking (Remission) vs. Those Who Didn't Quit

Brain Lesions in People Who Stopped Smoking (Remission) vs. Those Who Didn't Quit



NATURE MEDICINE | VOL 28 | JUNE 2022 | 1249–1255 | www.nature.com/naturemedicine

Brain Lesions in People Who Stopped Smoking (Remission) vs. Those Who Didn't Quit

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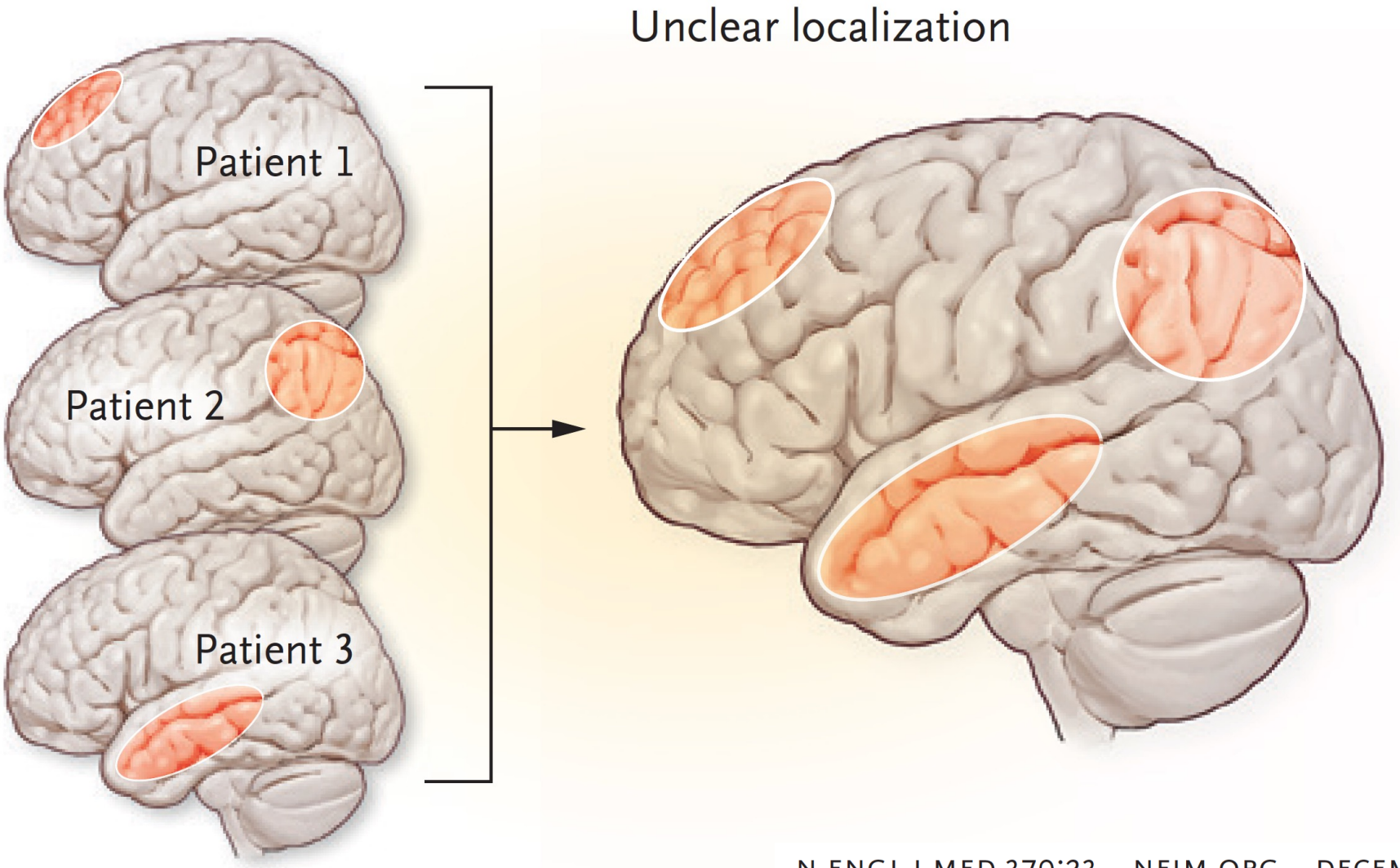
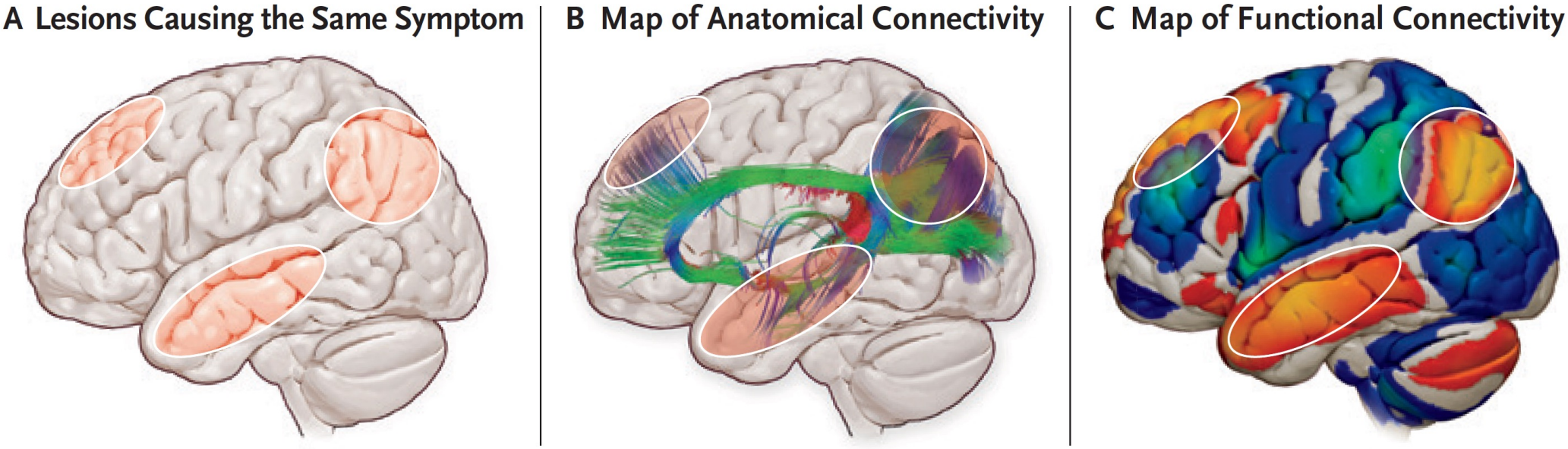
Different Lesion Locations across Patients with the Same Symptom



Network-based Pathophysiology



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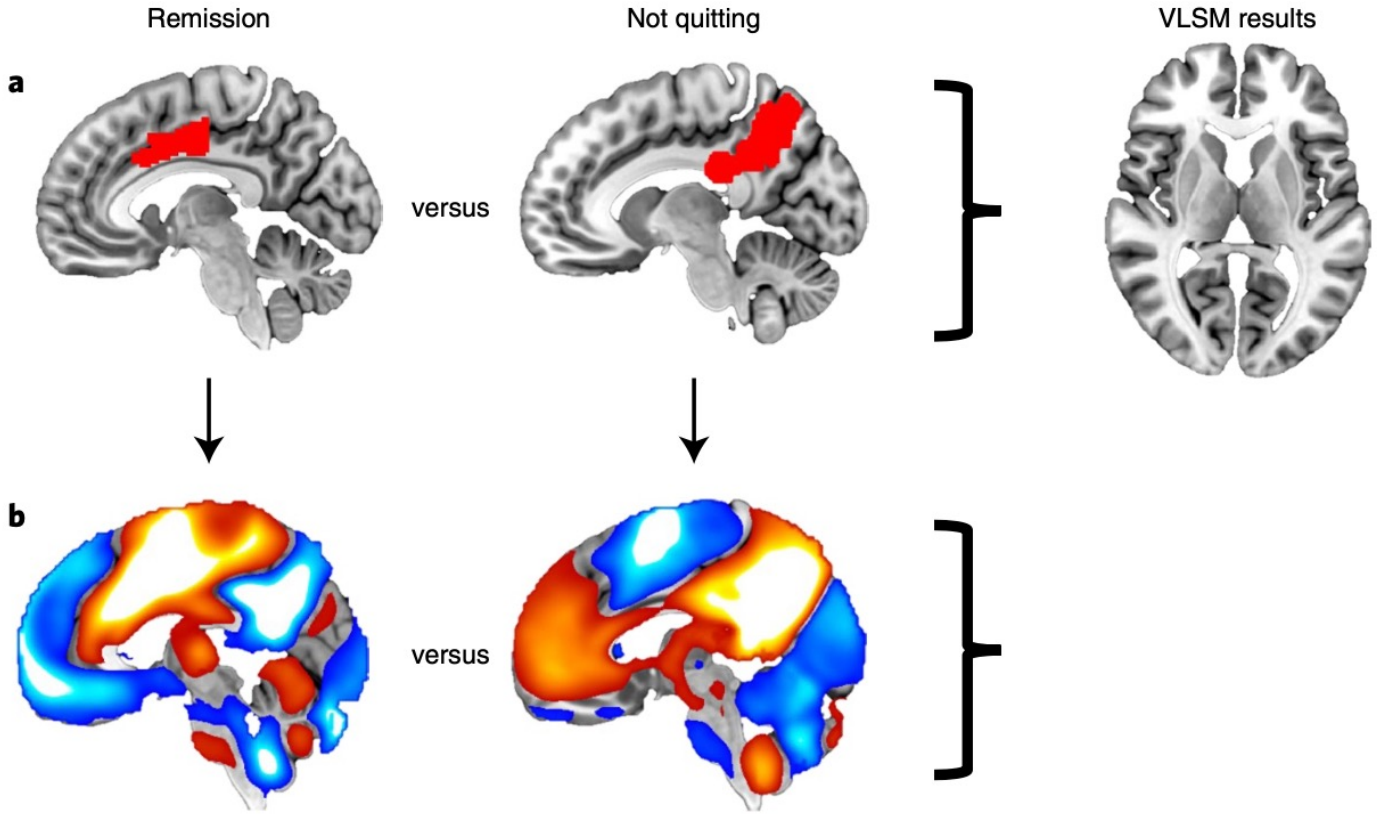

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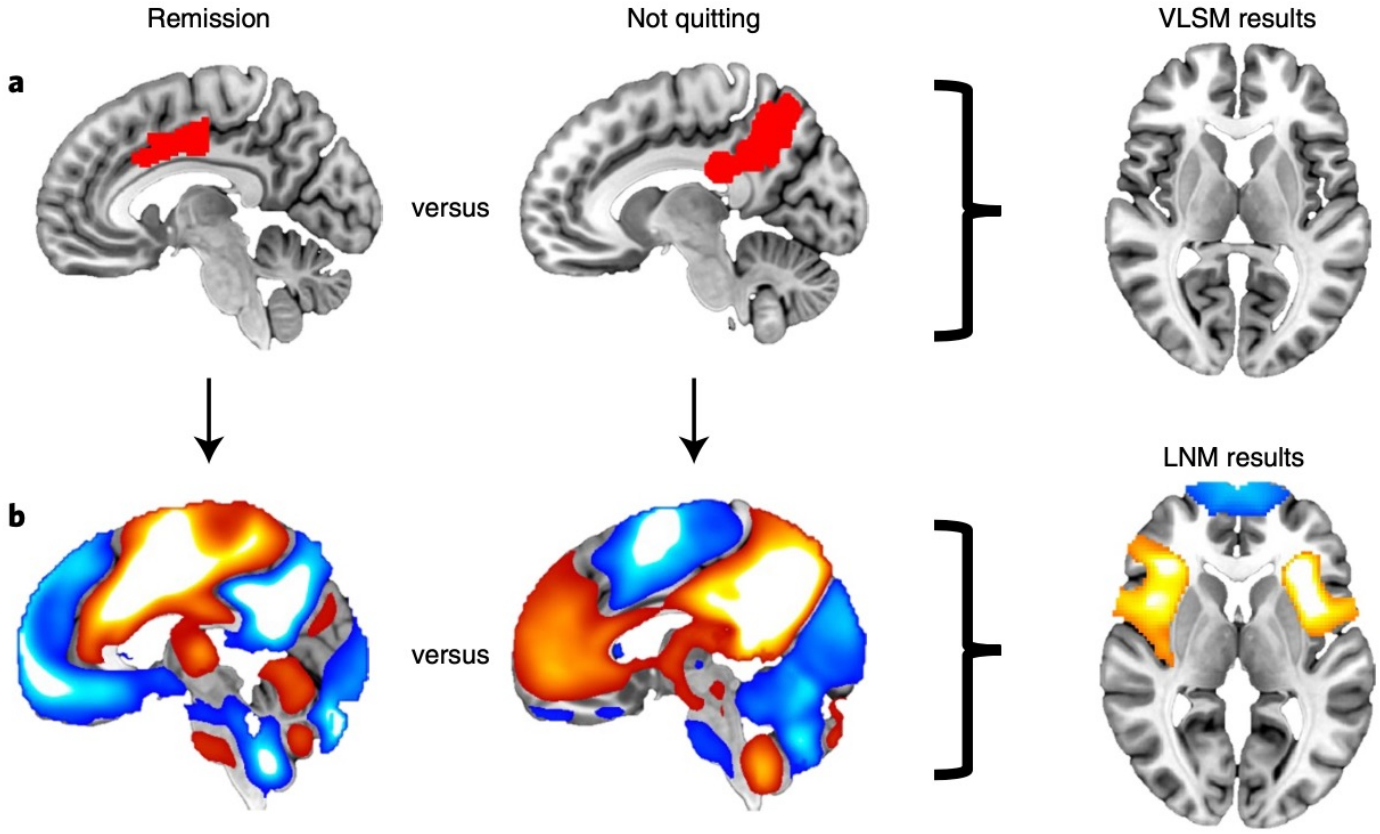

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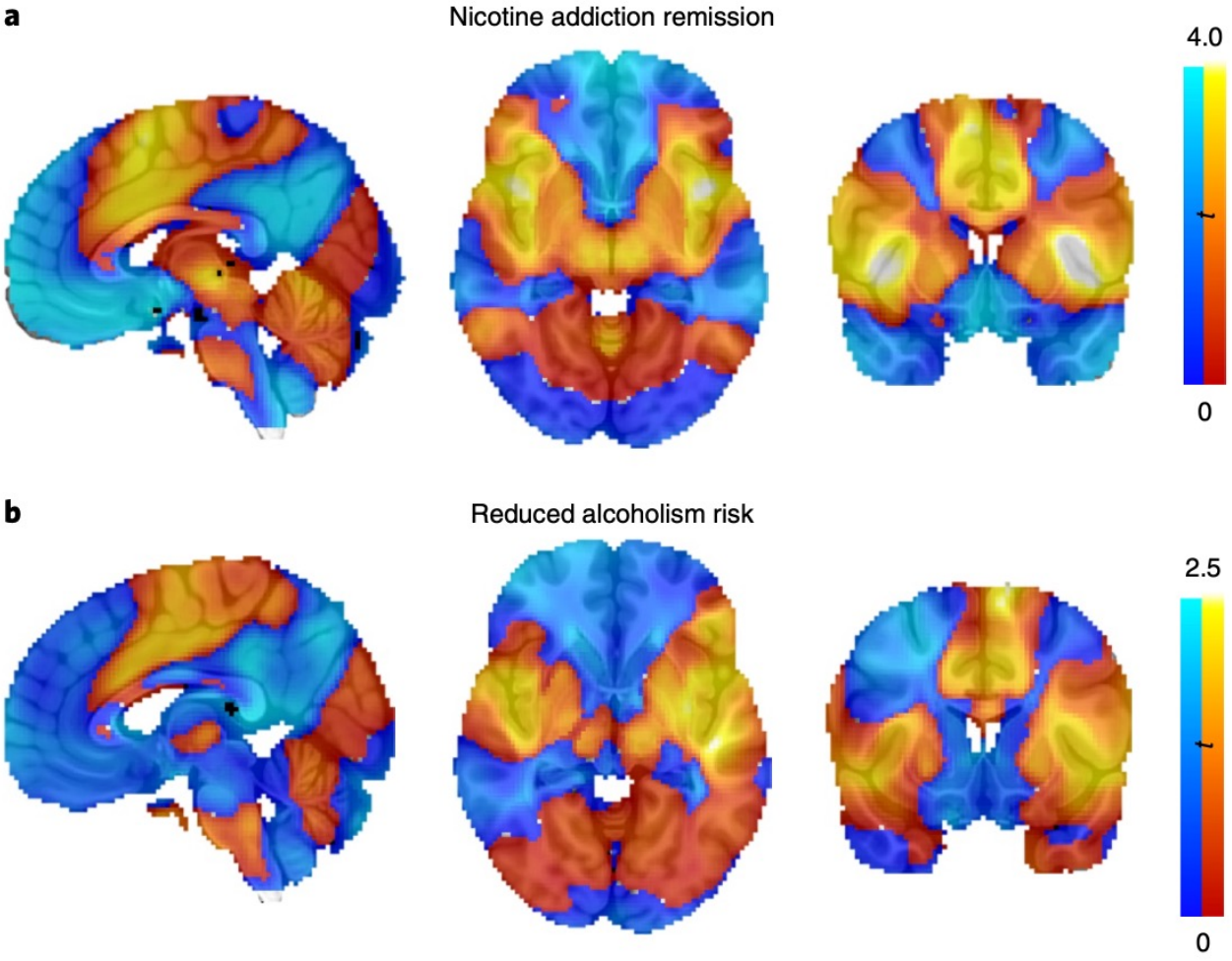
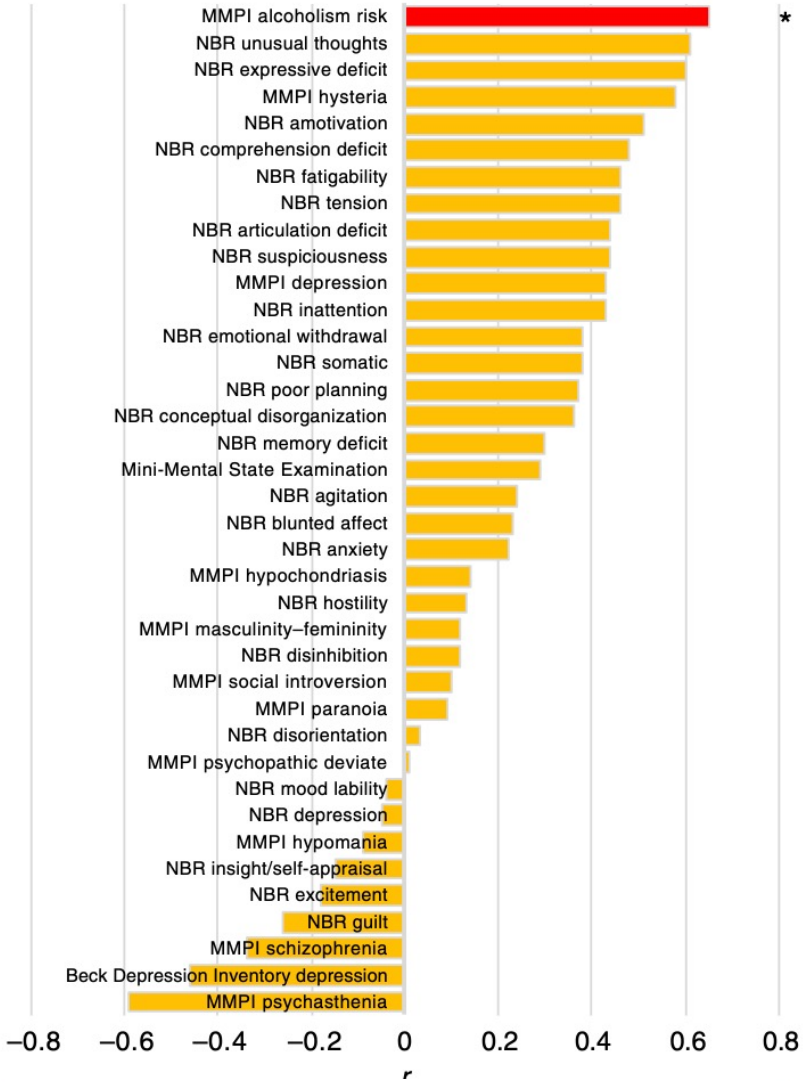
Replication of Results in Alcohol Use Disorder



MMPI Alcoholism Risk



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The New York Times

Le Monde

nature medicine

ARTICLES

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Check for updates

OPEN

Brain lesions disrupting addiction map to a common human brain circuit

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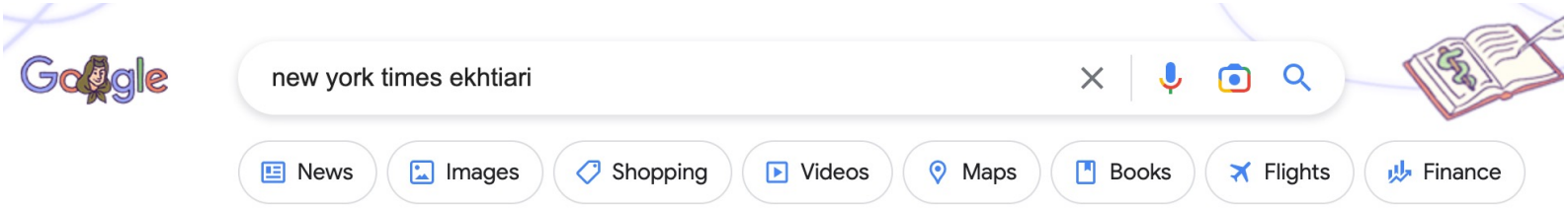
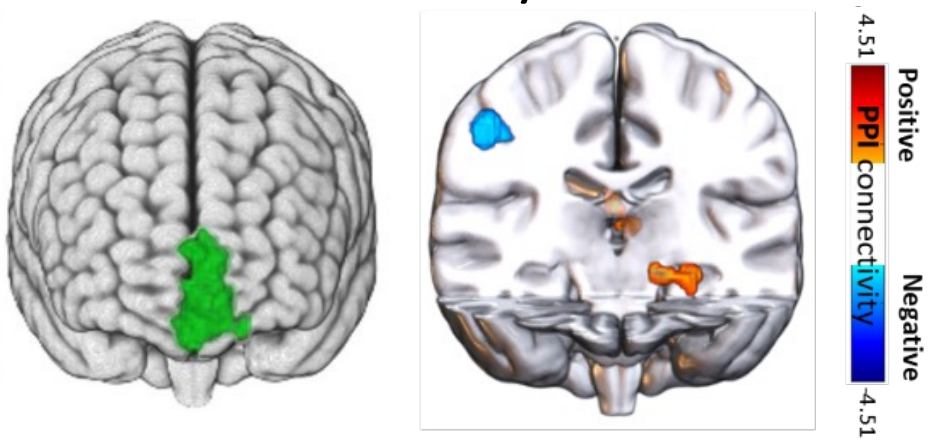
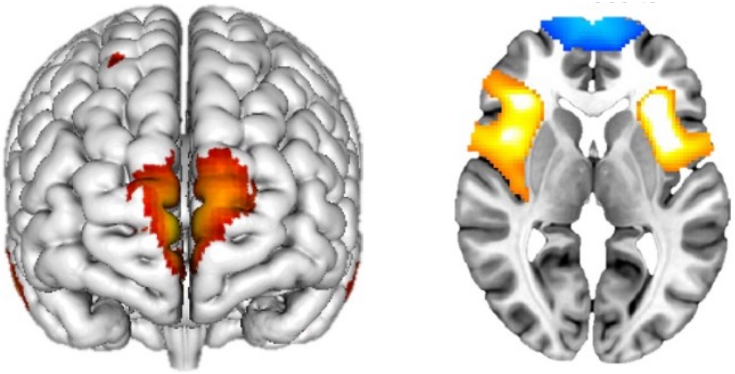


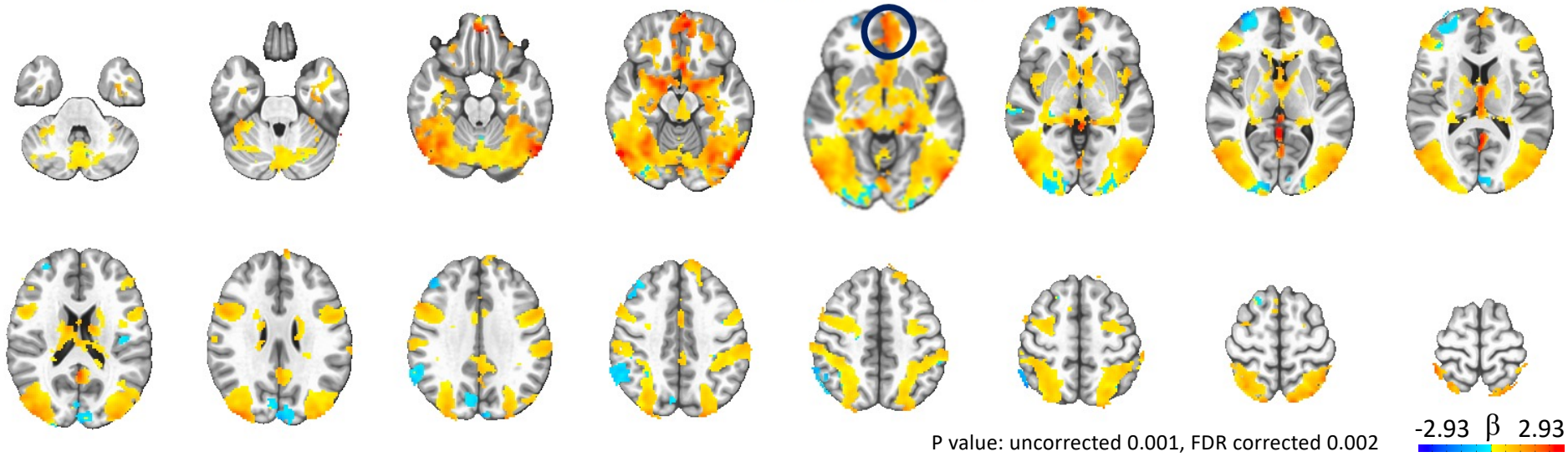
Brain Connectivity Results



Lesion Study Results



Brain Response to Drug Cues (Cue Reactivity)



P value: uncorrected 0.001, FDR corrected 0.002

(Ekhtiari, et al., 2021)

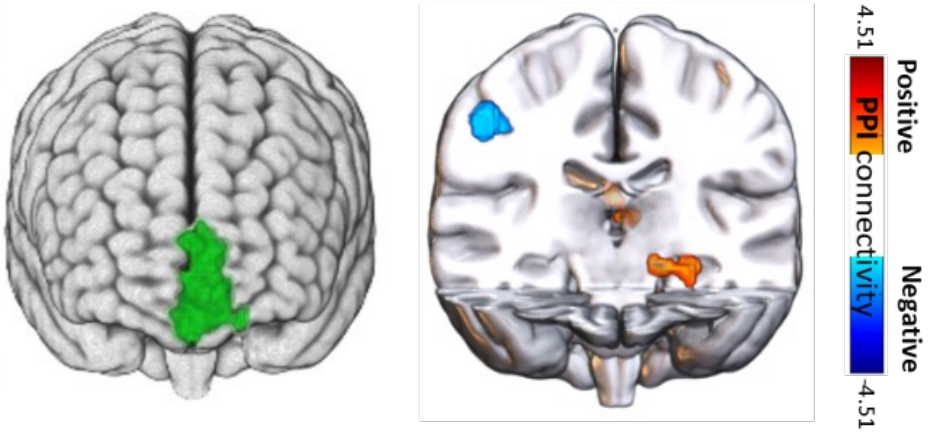
frontiers in PSYCHIATRY

ORIGINAL RESEARCH ARTICLE
published: 27 February 2014
doi: 10.3389/fpsyt.2014.00016

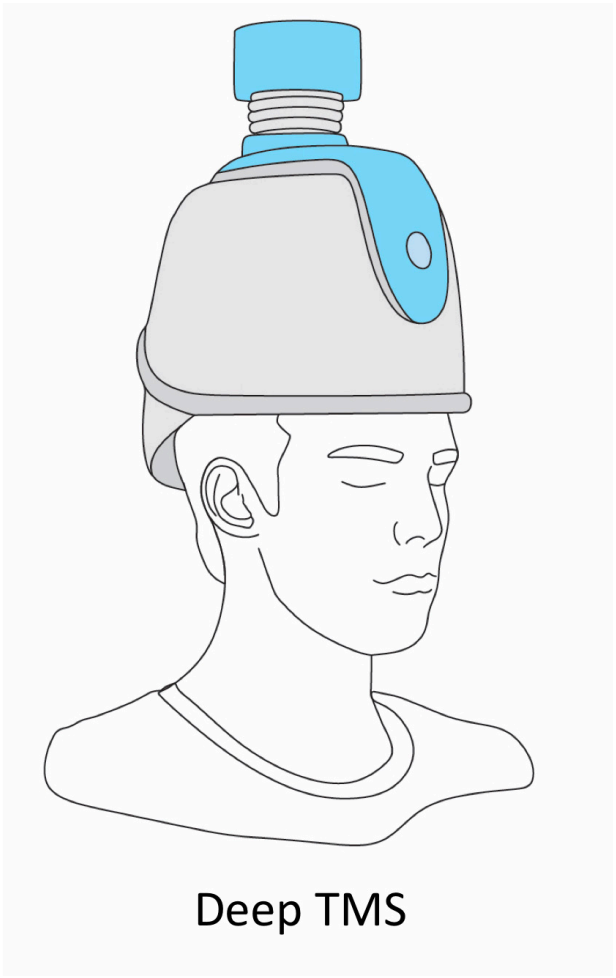
Cortico-amygdala coupling as a marker of early relapse risk in cocaine-addicted individuals

Meredith J. McHugh[1], Catherine H. Demers[1], Betty Jo Salmeron[1], Michael D. Devous Sr.[2], Elliot A. Stein[1]*† and Bryon Adinoff[3,4]†*

Cue Reactivity Connectivity



"rsFC between the left centromedial amygdala and ventromedial prefrontal cortex/ rostral anterior cingulate cortex predicts relapse"



Deep TMS

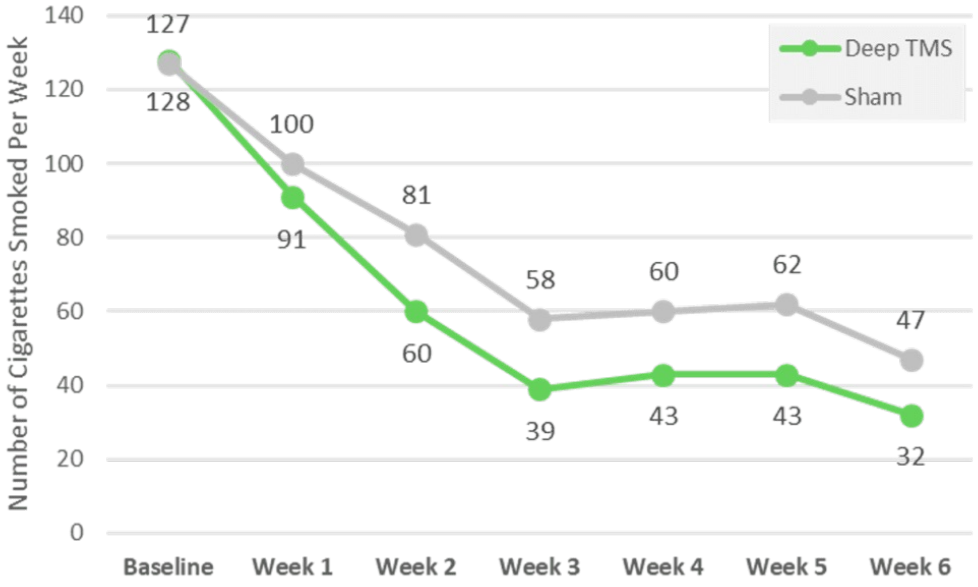
Deep TMS Treatment Sessions

Week 1	Week 2	Week 3	Week 4	Week 5	Week 6
5 treatments	*5 treatments*	*5 treatments*	*1 treatment*	*1 treatment*	*1 treatment*

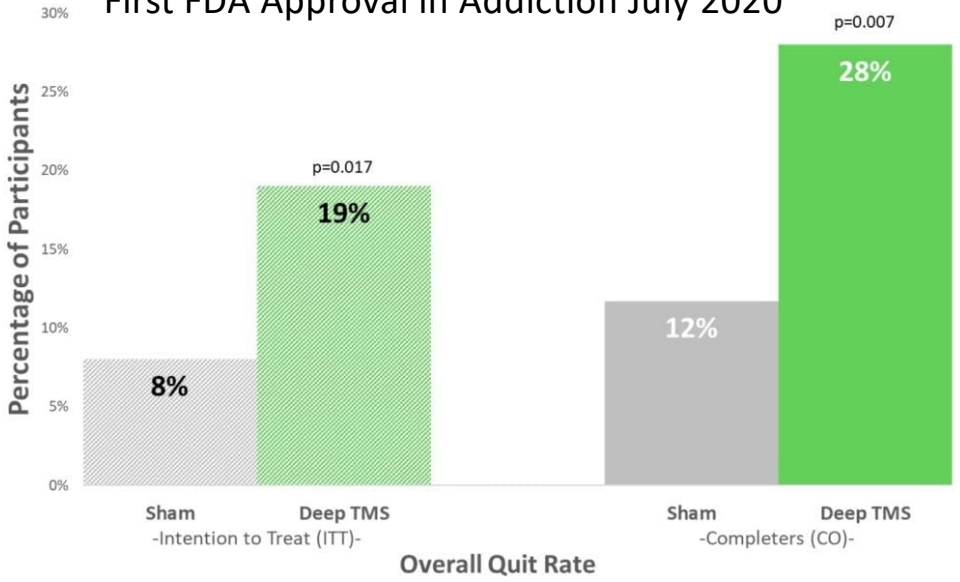
18 treatments

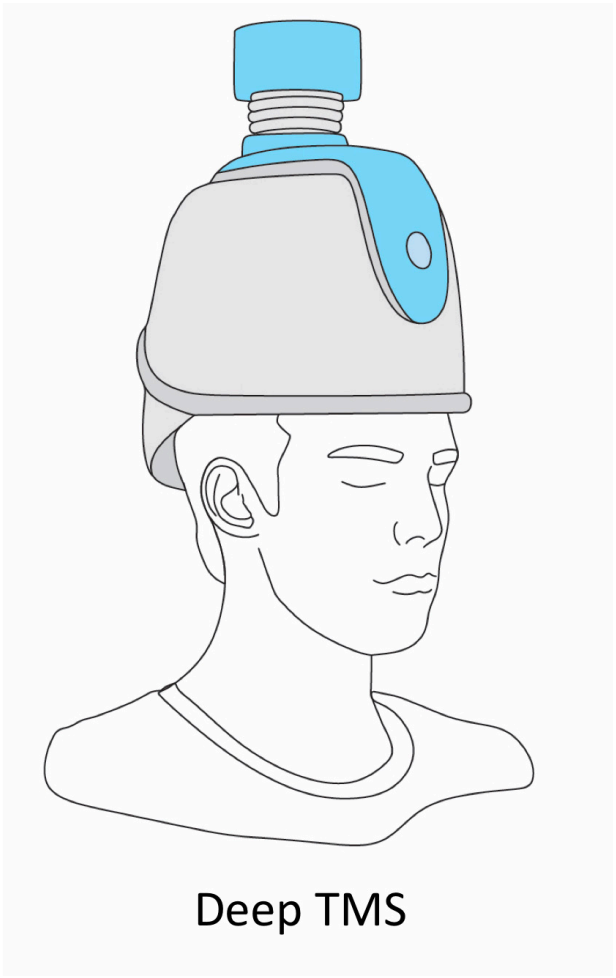
Each session typically takes 25-30 minutes and includes:

Provocation Administration + ***18 Minute TMS Protocol*** + ***Brief Counseling***



First FDA Approval in Addiction July 2020





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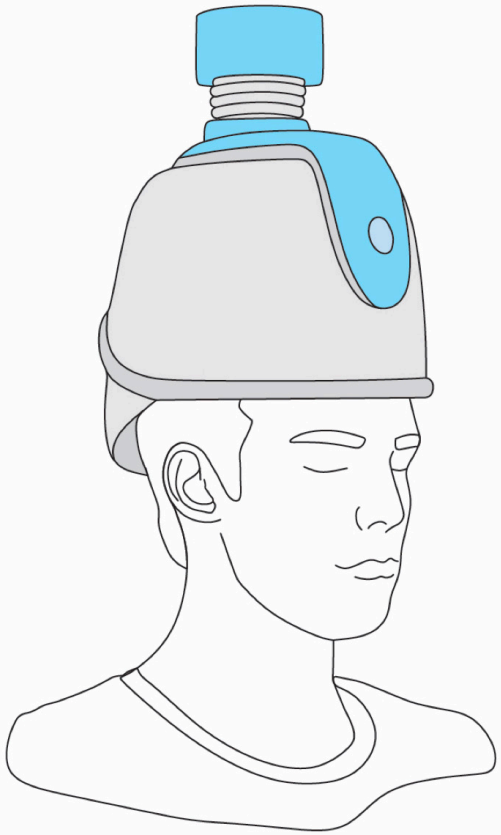
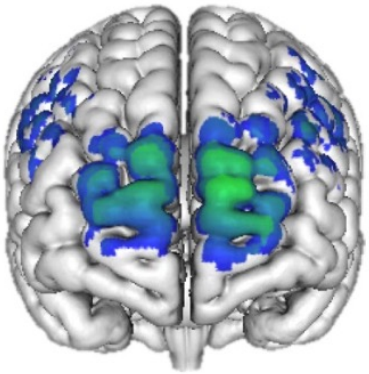


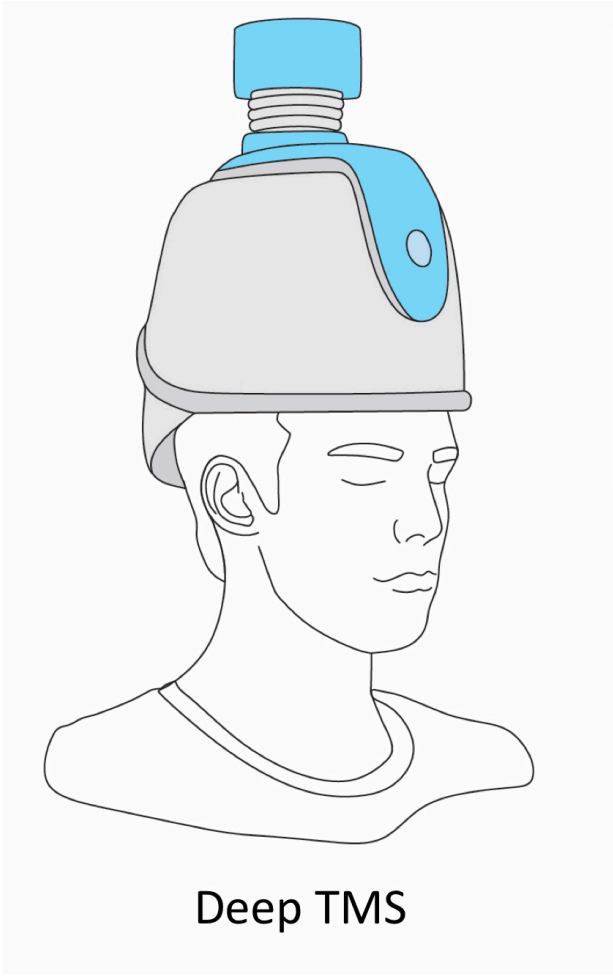
Deep TMS

Smoking (H4 coil)



Coil electrical field strength

70 Percentage of maximum 100



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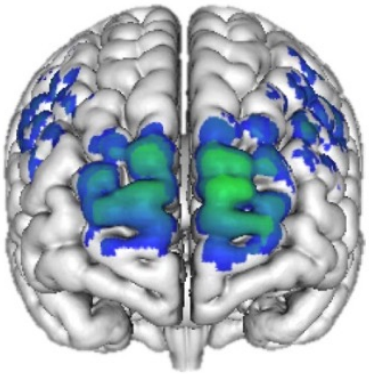
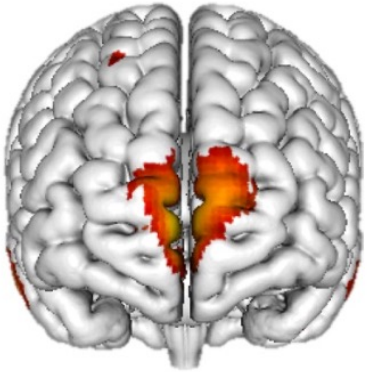
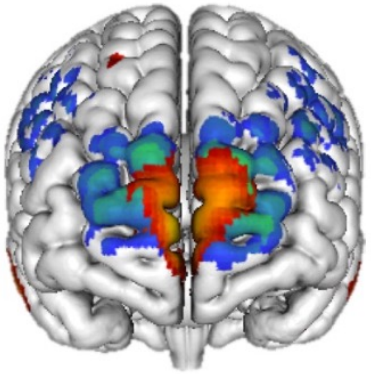


Brain Lesion Map





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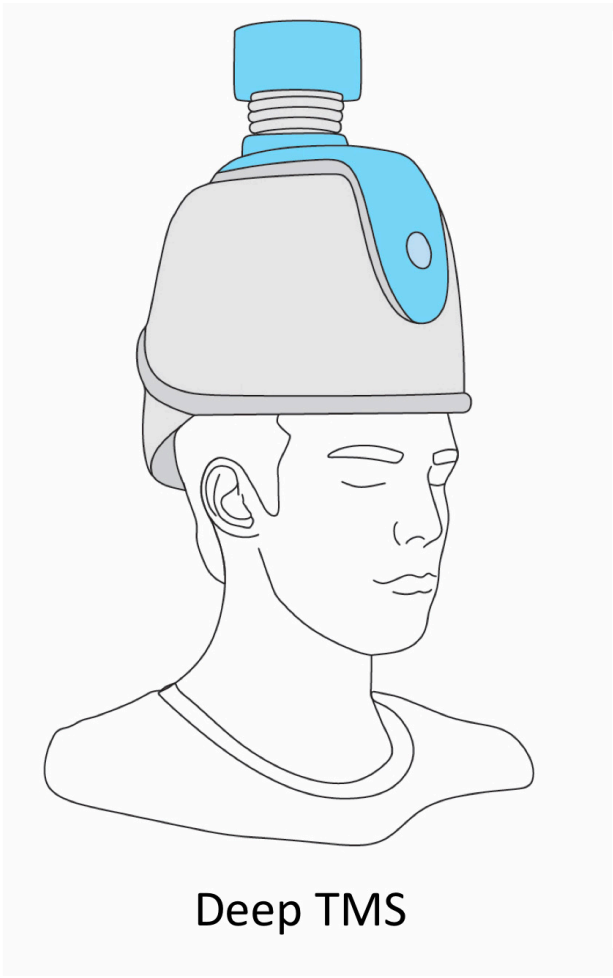


Deep TMS

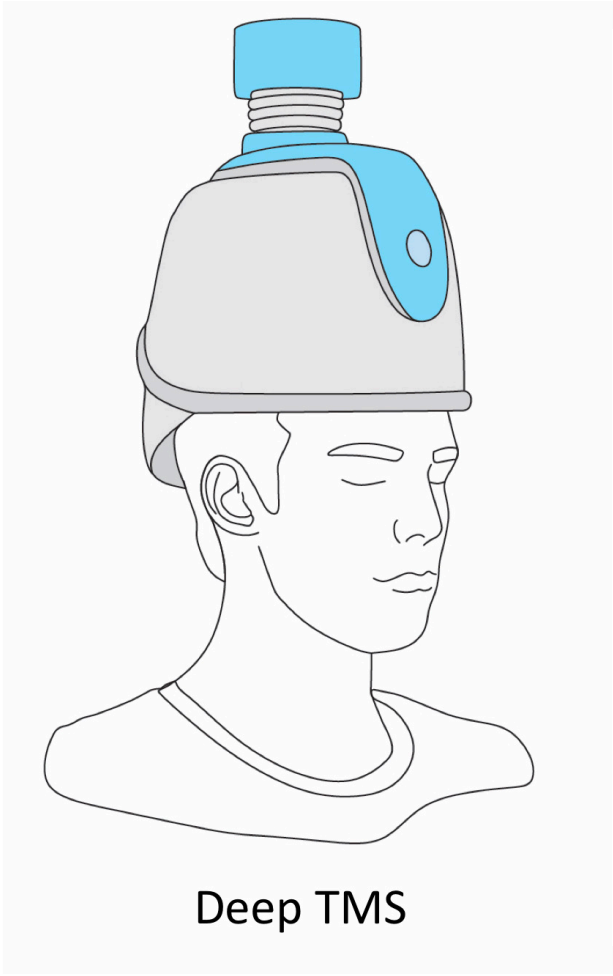
Smoking (H4 coil)

Alcoholism (H7 coil)

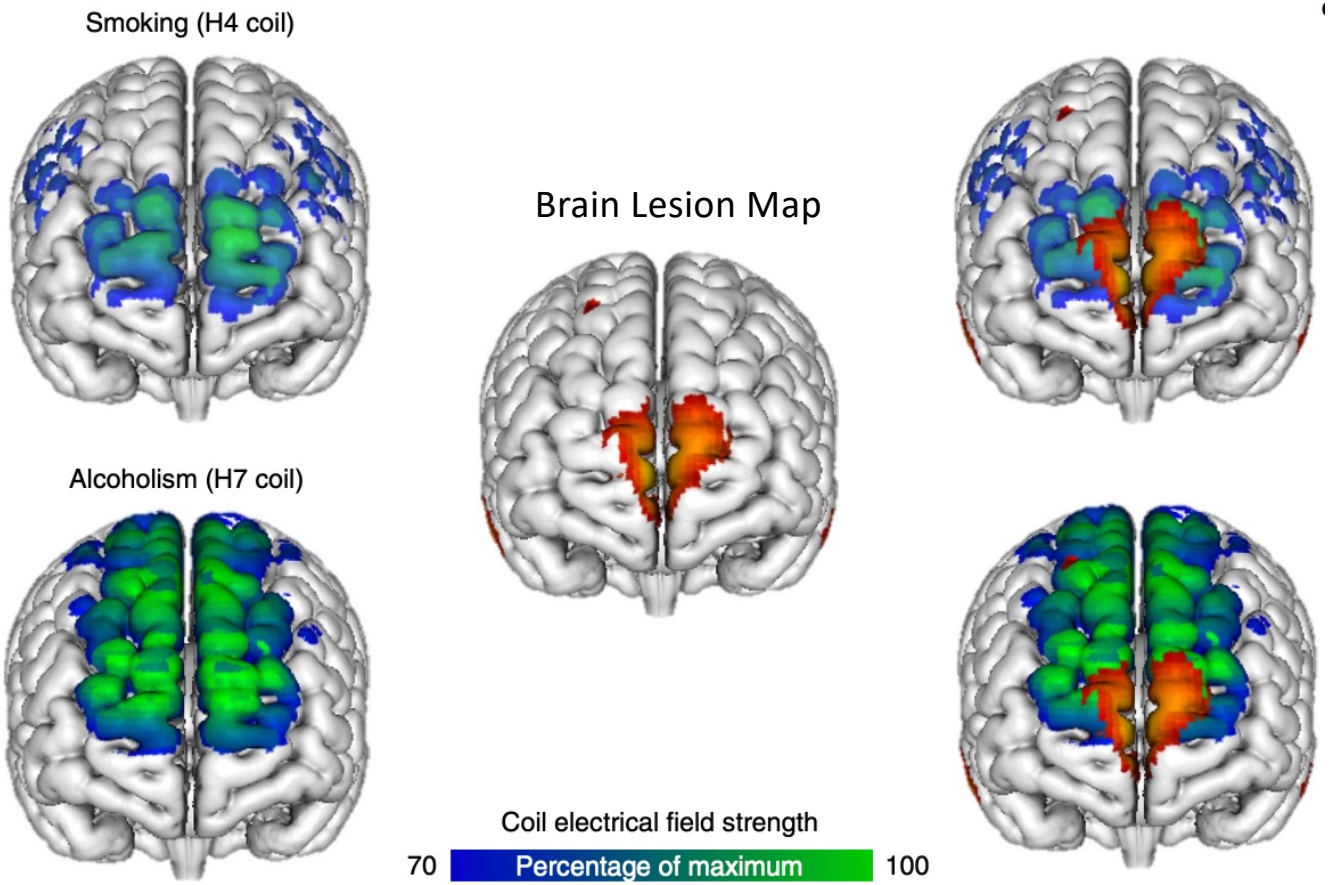
Brain Lesion Map

Coil electrical field strength

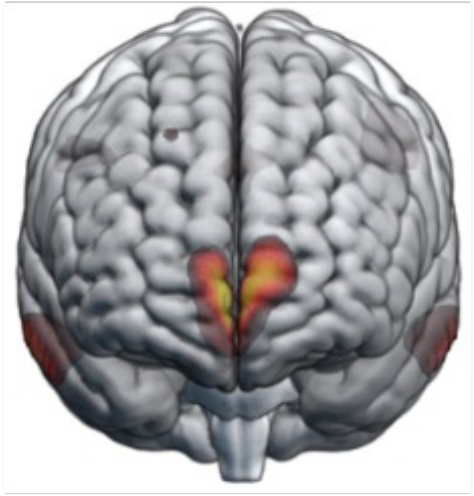
70 Percentage of maximum 100



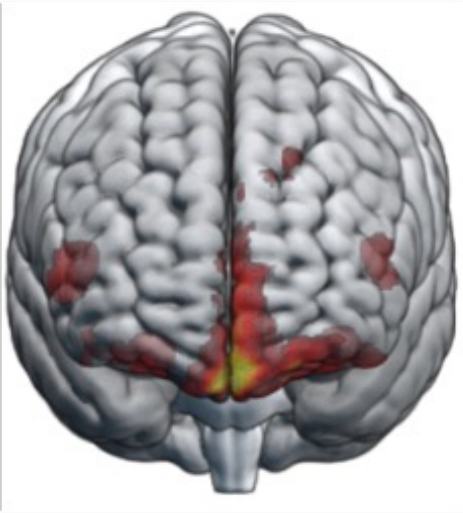
Deep TMS


Smoking (H4 coil)
Alcoholism (H7 coil)
Brain Lesion Map
Coil electrical field strength
70
Percentage of maximum
100

Lesion-based, Alcohol & Smoking

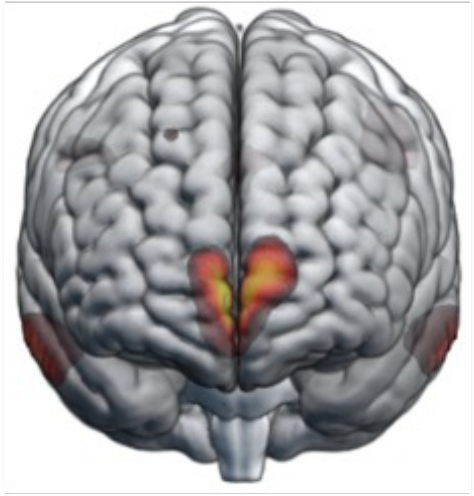


Cue-reactivity, Methamphetamine



Colleen A Hanlon
Wake Forest University
USA

Lesion-based, Alcohol & Smoking



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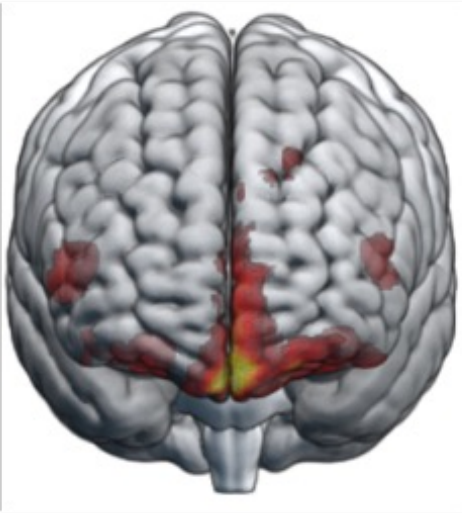
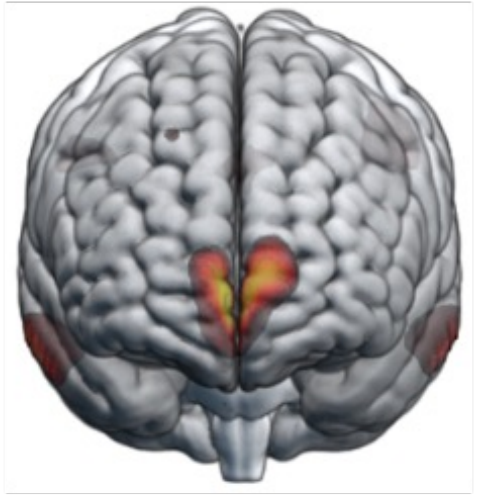


Michael Fox
Harvard Medical School
USA

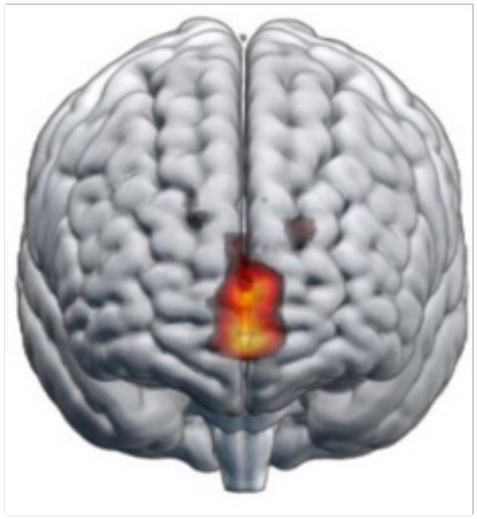
Colleen A Hanlon
Wake Forest University
USA

Hamed Ekhtiari
University of Minnesota
USA

a. Lesion-based, Alcohol & Smoking

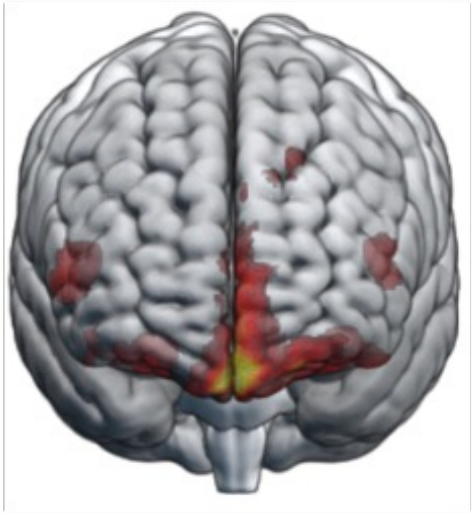


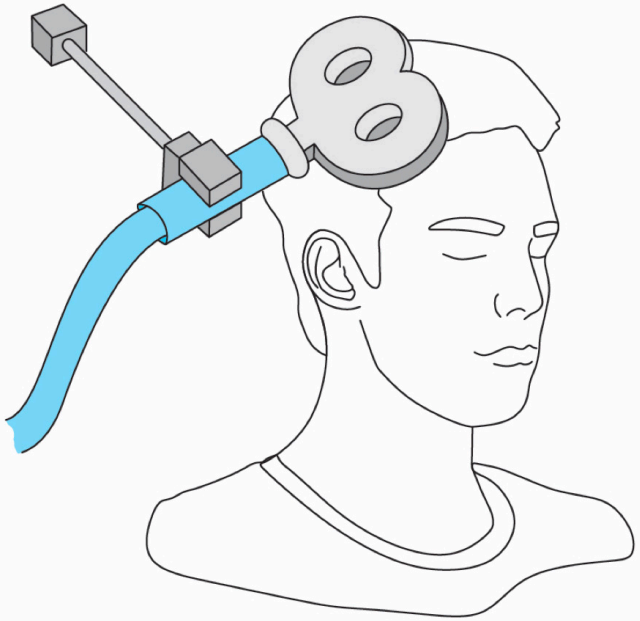
b. Cue-reactivity, Alcohol



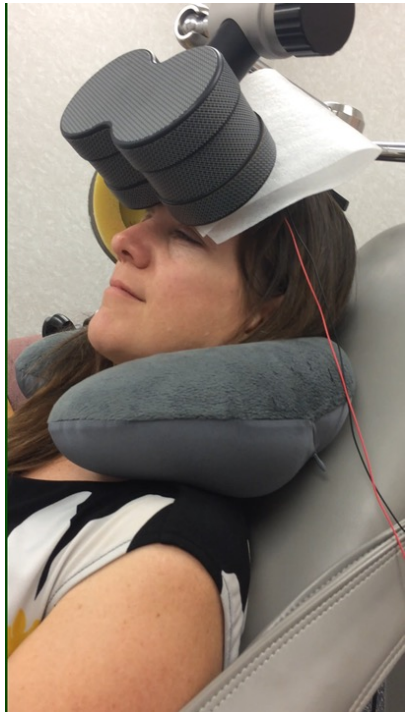
c. Cue-reactivity, Smoking

d. Cue-reactivity, Methamphetamine

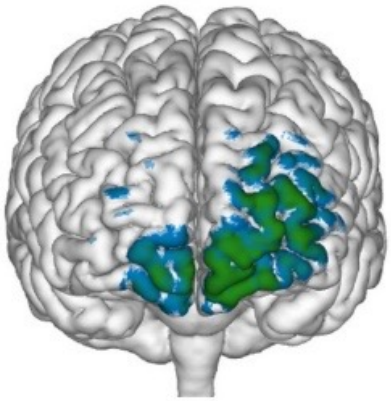


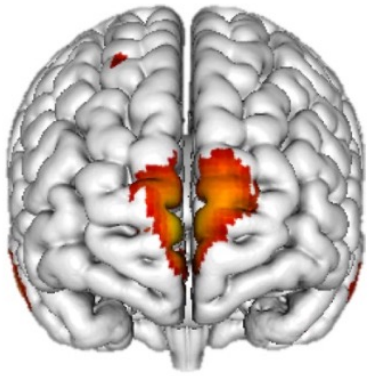


Conventional TMS



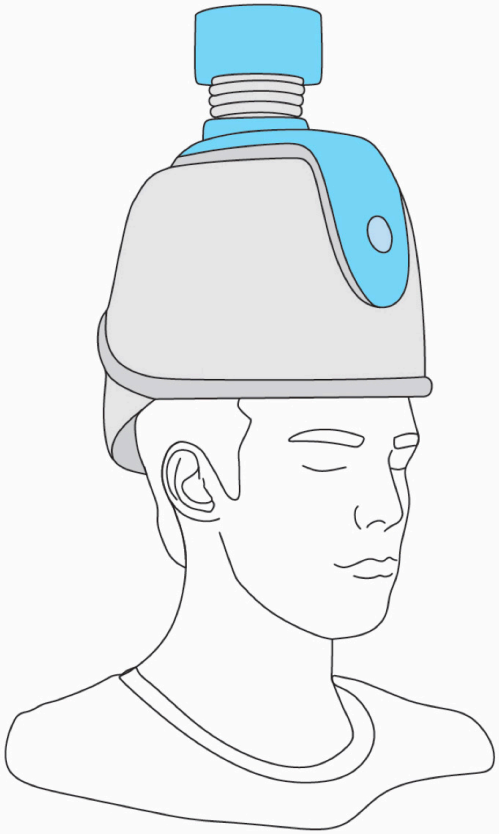
Colleen Hanlon MPFC Target



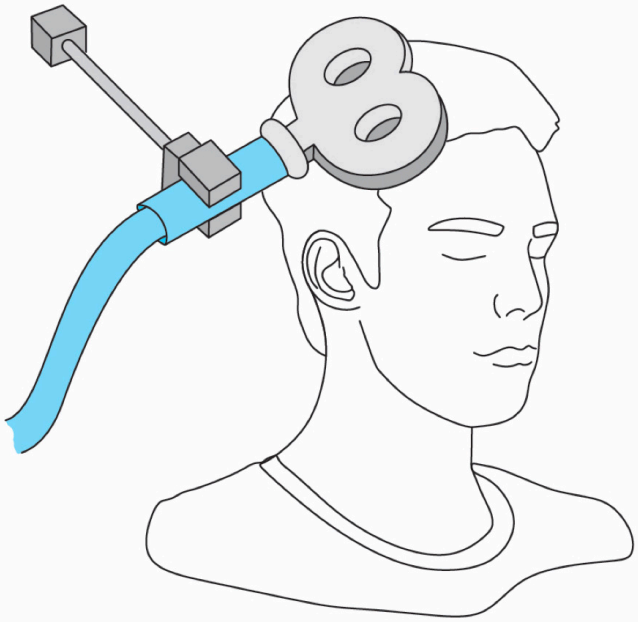


Lesion Study Results

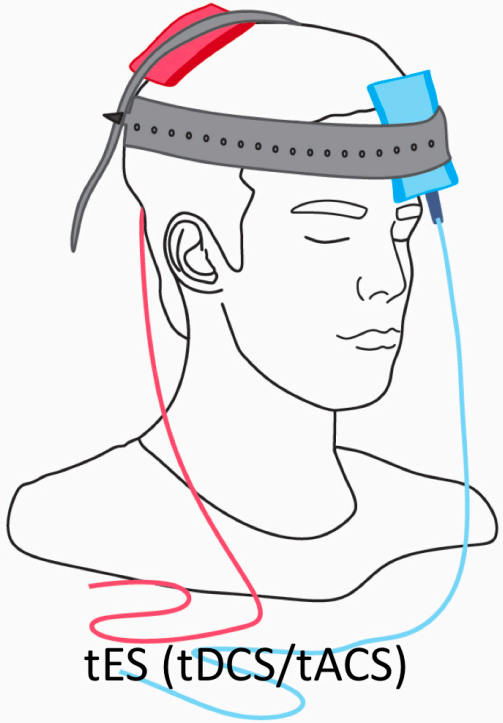
Non-Invasive Brain Stimulation (NIBS) Interventions



Deep TMS

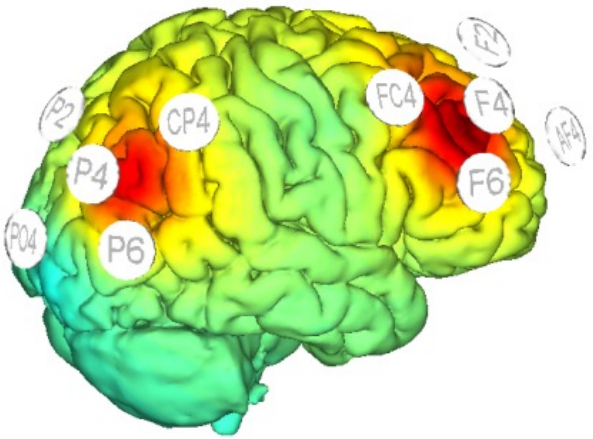


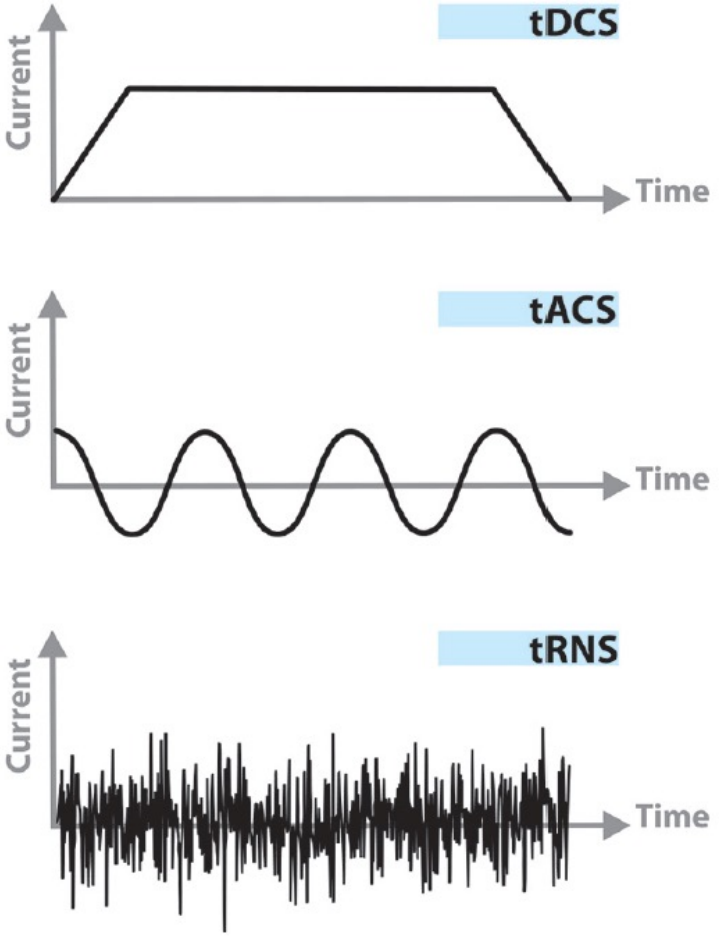
Conventional TMS



tES (tDCS/tACS)

tES: Transcranial Electrical Stimulation

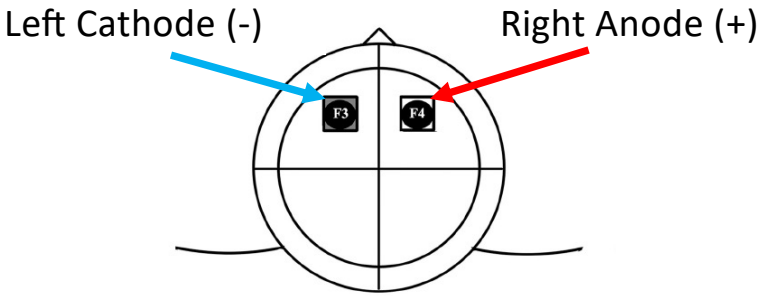





platowork

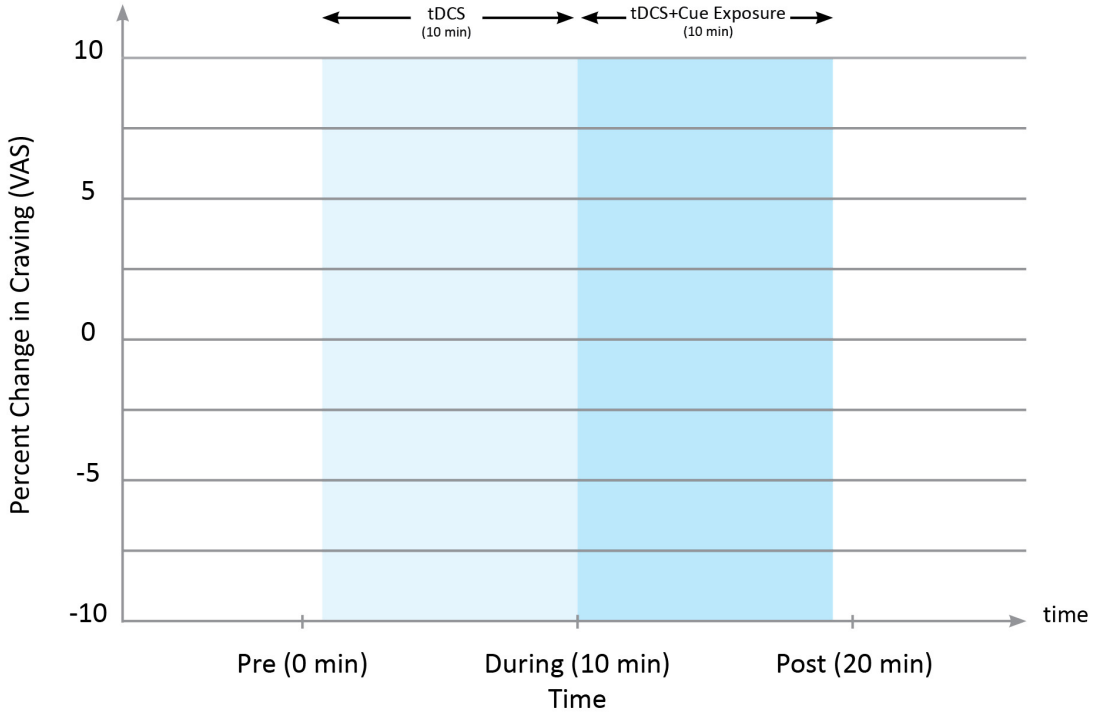
International Journal of Neuropsychopharmacology (2014), **17**, 1591–1598.
doi:10.1017/S1461145714000686

State dependent effect of transcranial direct current stimulation (tDCS) on methamphetamine craving



Alireza Shahbabaie[1,2,3], Mehrshad Golesorkhi[1,3], Behnam Zamanian[2], Mitra Ebrahimpoor[3], Fatemeh Keshvari[4], Vahid Nejati[4], Felipe Fregni[5] and Hamed Ekhtiari[1,2,3]

	Descriptive statistics
Gender (men)	30/30
Age	29.90±1.04
Education (years)	11.90±0.39
Duration of meth abstinence (d)	73.33±9.64
Duration of meth dependence (months)	58±5.75
Marital status (married)	30/12
Number of subjects with a history of opium abuse	30/19
Number of subjects with a history of heroin abuse	30/2
Number of subjects with a history of crystalline heroin abuse	30/6
Number of subjects with a history of alcohol abuse	30/17
Number of subjects with a history of hashish abuse	30/22
Number of subjects with a history of cocaine abuse	30/3
Number of subjects with a history of cigarette smoking	30/29



International Journal of Neuropsychopharmacology (2014), **17**, 1591–1598.
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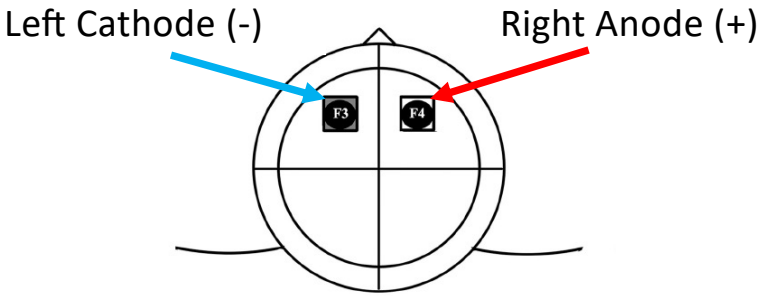

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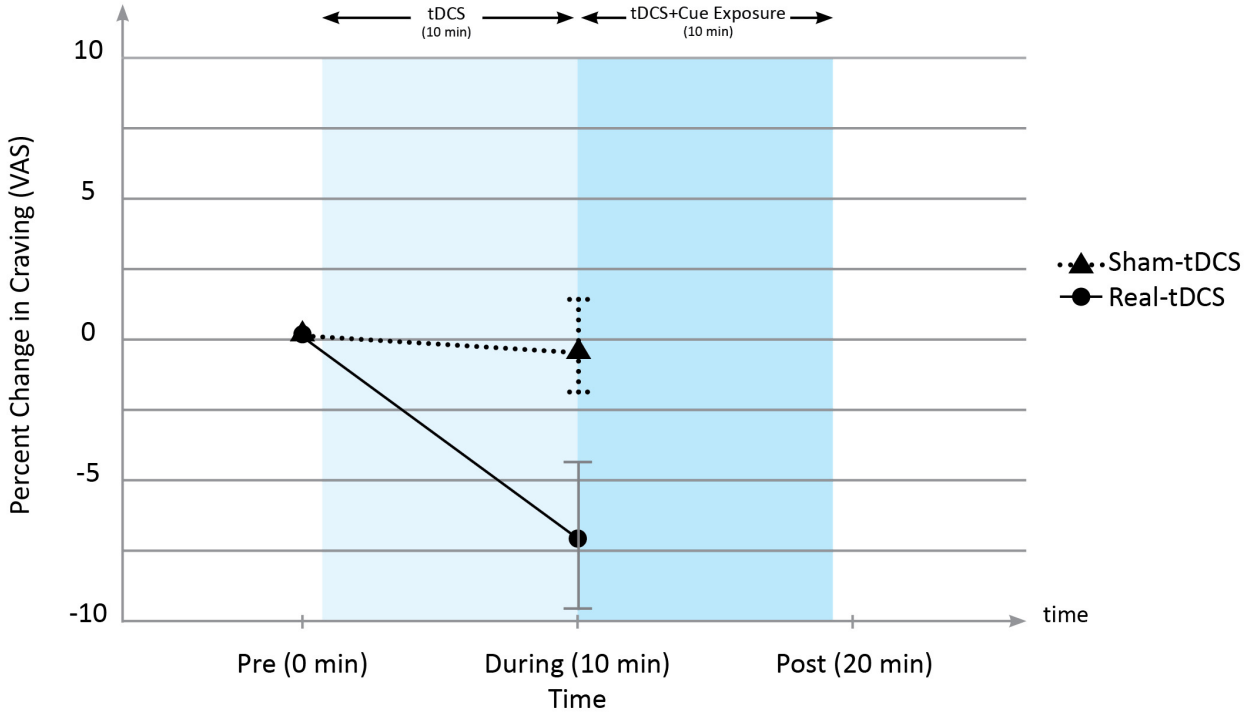
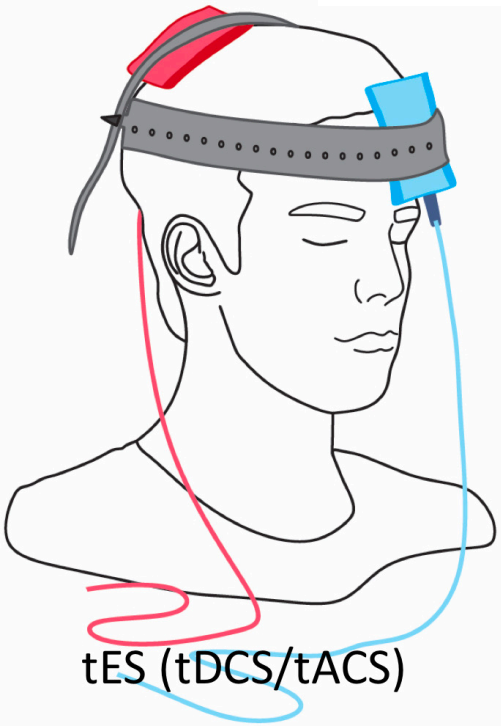
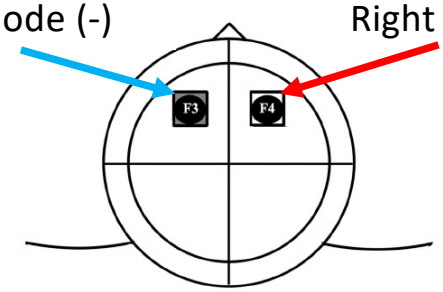


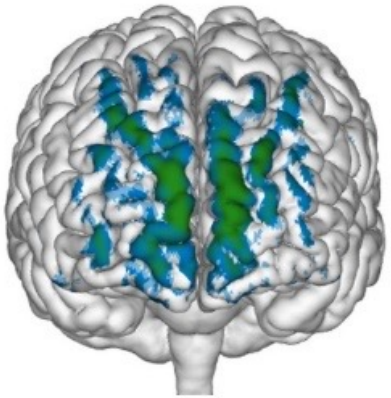


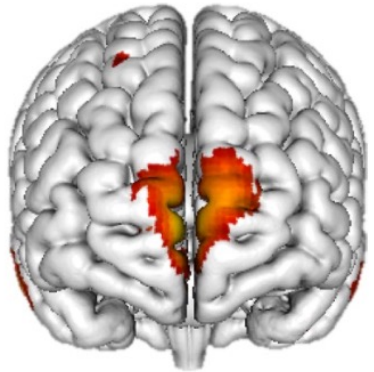
tES (tDCS/tACS)

Left Cathode (-)

Right Anode (+)







Lesion Study Results

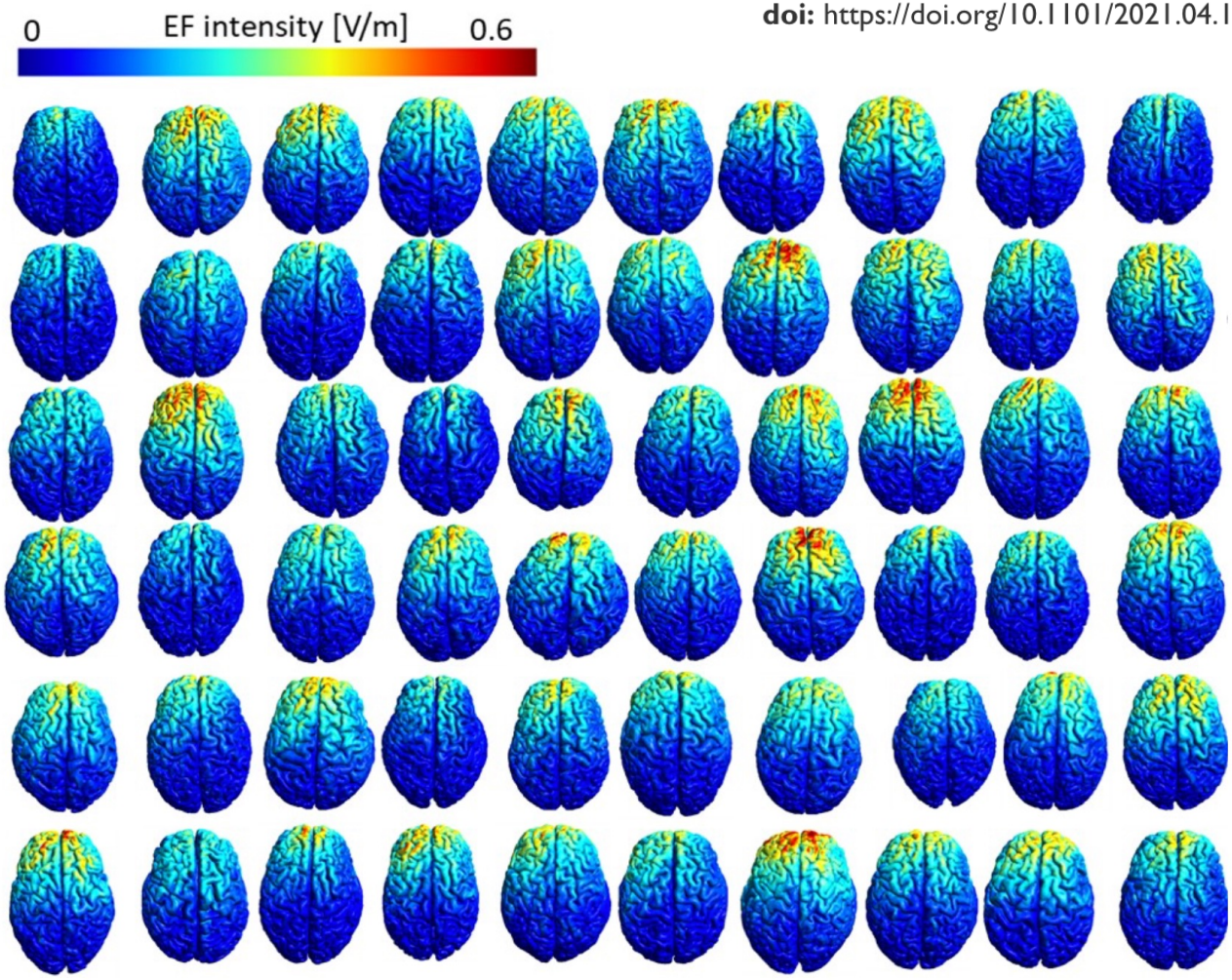
(Soleimani, et al., unpublished)

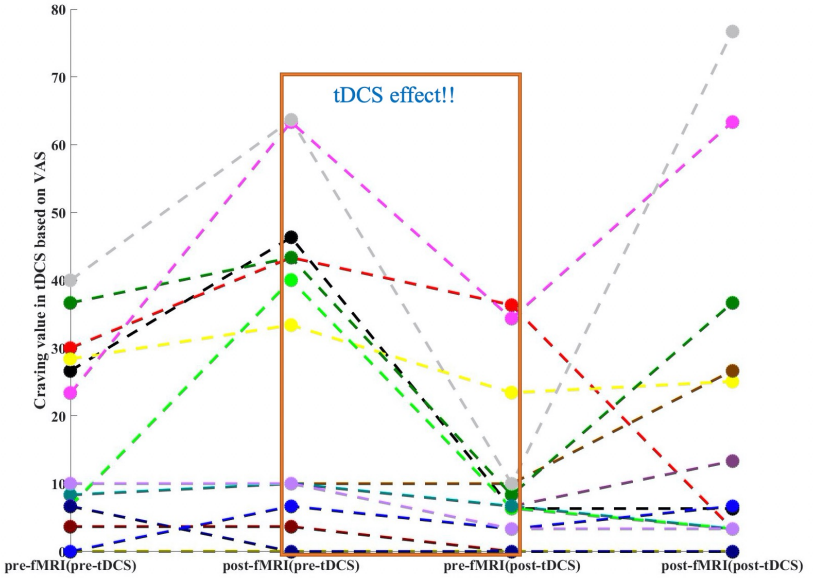
HUMAN BRAIN MAPPING Open Access

Transcranial Direct Current Stimulation to Modulate fMRI Drug Cue Reactivity in Methamphetamine Users: A Randomized Clinical Trial

Hamed Ekhtiari, Ghazaleh Soleimani, Rayus Kuplicki, Hung-Wen Yeh, Yoon-Hee Cha, Martin Paulus

doi: https://doi.org/10.1101/2021.04.12.21255366





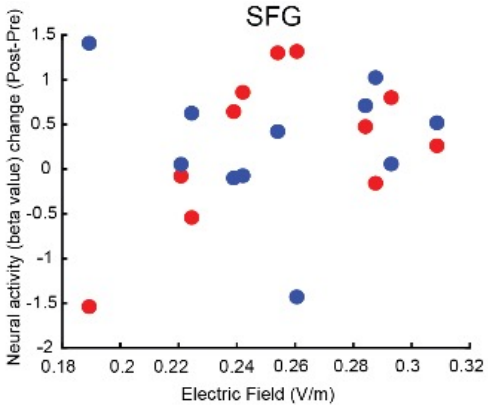
Received: 19 June 2019 | Revised: 9 November 2019 | Accepted: 10 December 2019
DOI: 10.1002/hbm.24908

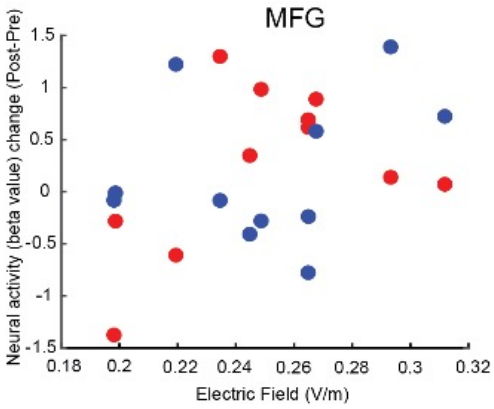
REVIEW ARTICLE

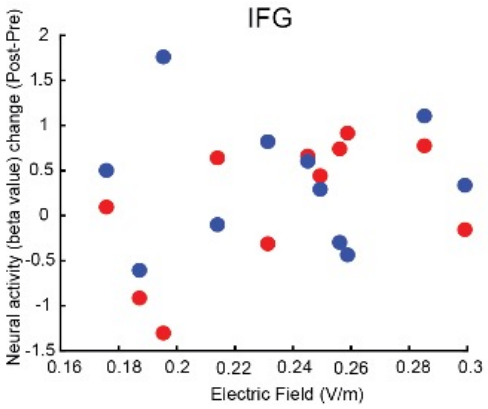
WILEY

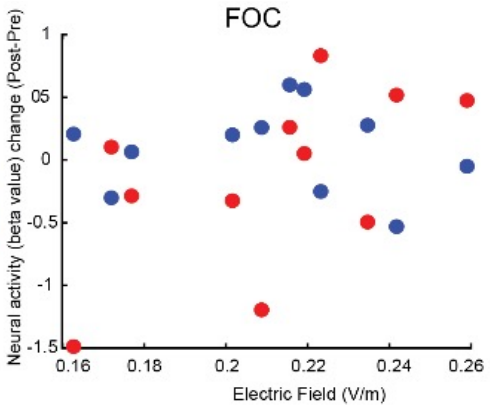
Methodology for tDCS integration with fMRI

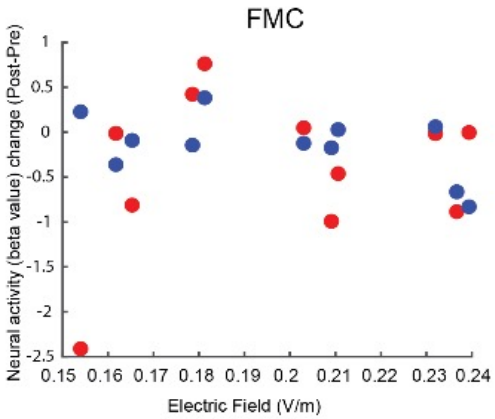
Zeinab Esmaeilpour[1] | A. Duke Shereen[2] | Peyman Ghobadi-Azbari[3] | Abhishek Datta[4] | Adam J. Woods[5] | Maria Ironside[6,7] | Jacinta O'Shea[8] | Ulrich Kirk[9] | Marom Bikson[1] | Hamed Ekhtiari[10]

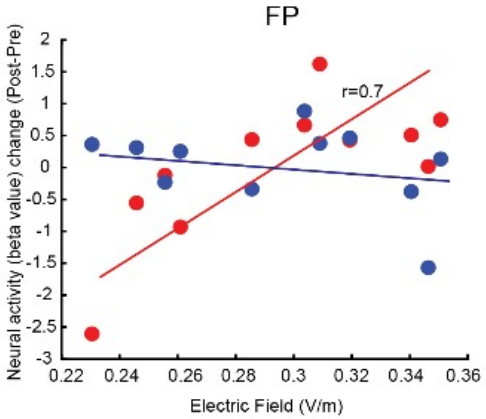


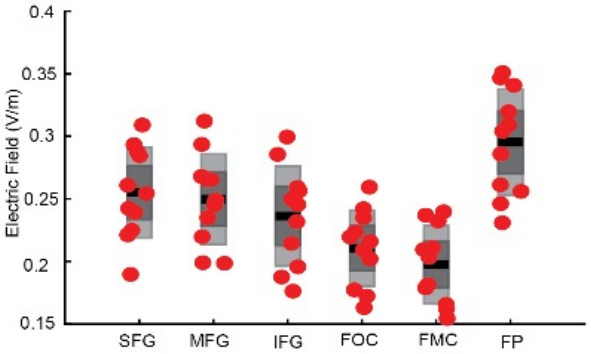


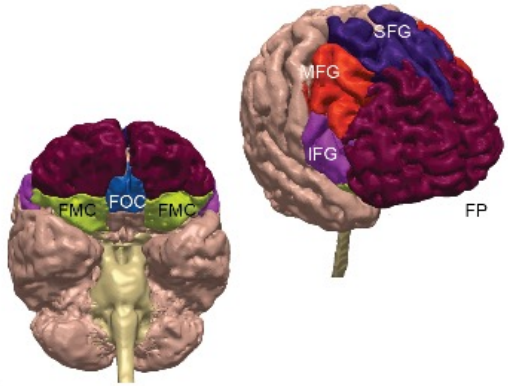










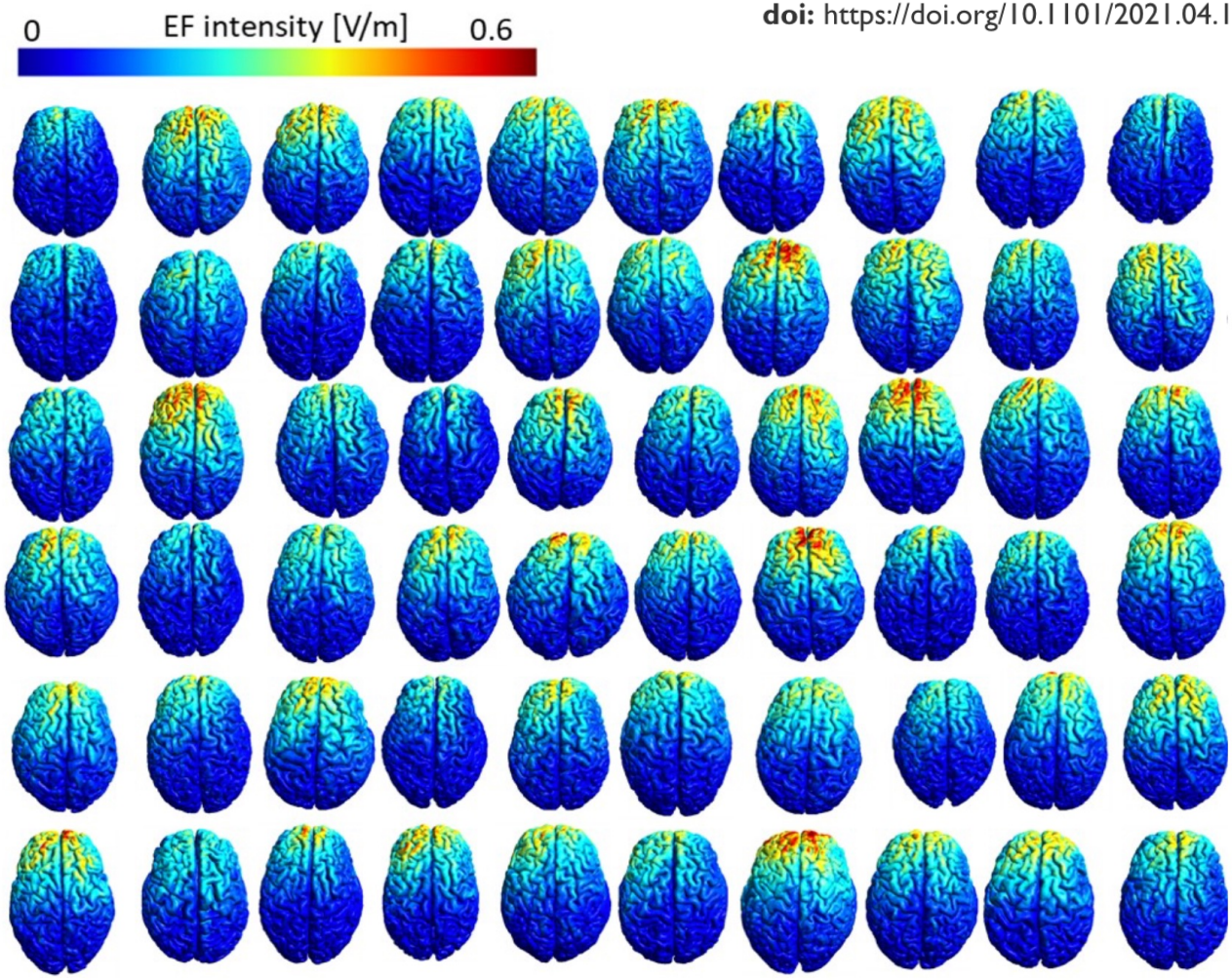


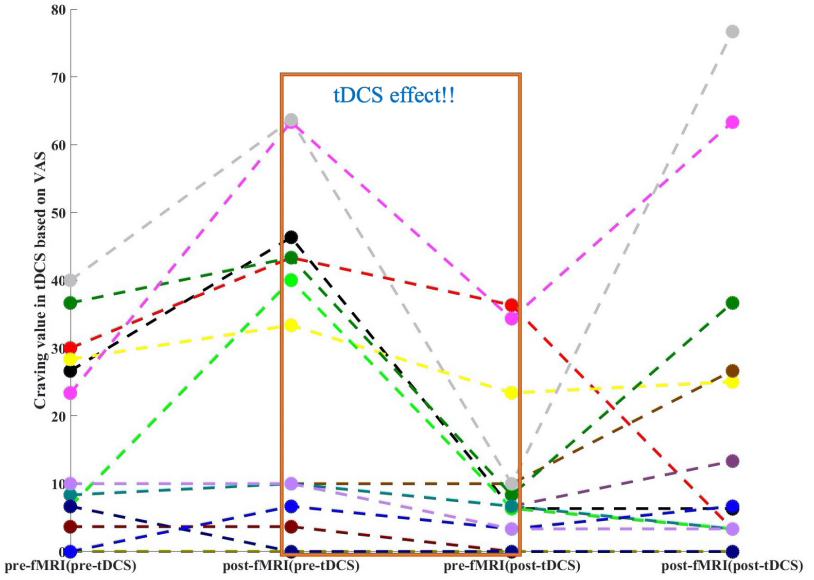
HUMAN BRAIN MAPPING Open Access

Transcranial Direct Current Stimulation to Modulate fMRI Drug Cue Reactivity in Methamphetamine Users: A Randomized Clinical Trial

Hamed Ekhtiari, Ghazaleh Soleimani, Rayus Kuplicki, Hung-Wen Yeh, Yoon-Hee Cha, Martin Paulus

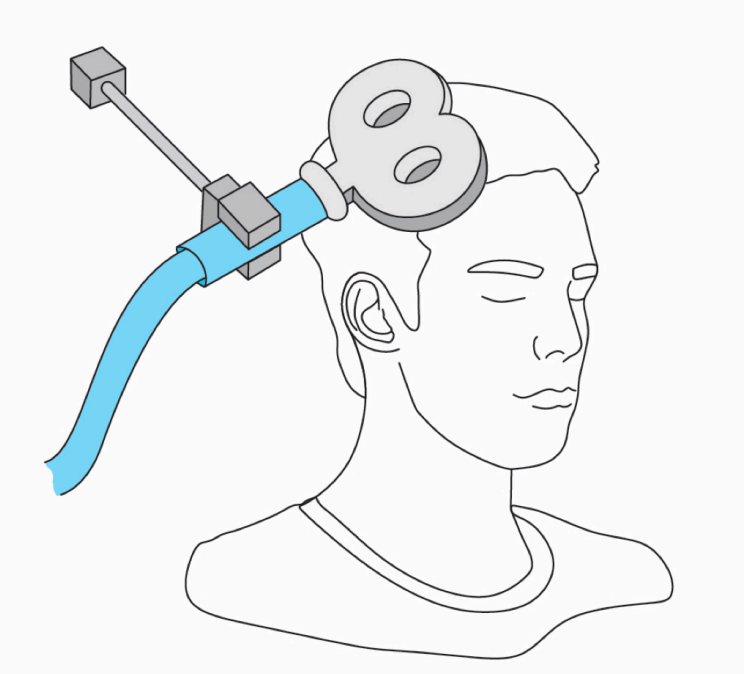
doi: https://doi.org/10.1101/2021.04.12.21255366





How to Optimize Stimulation in the Individual Level?

rTMS Received FDA Approval for Depression in 2008

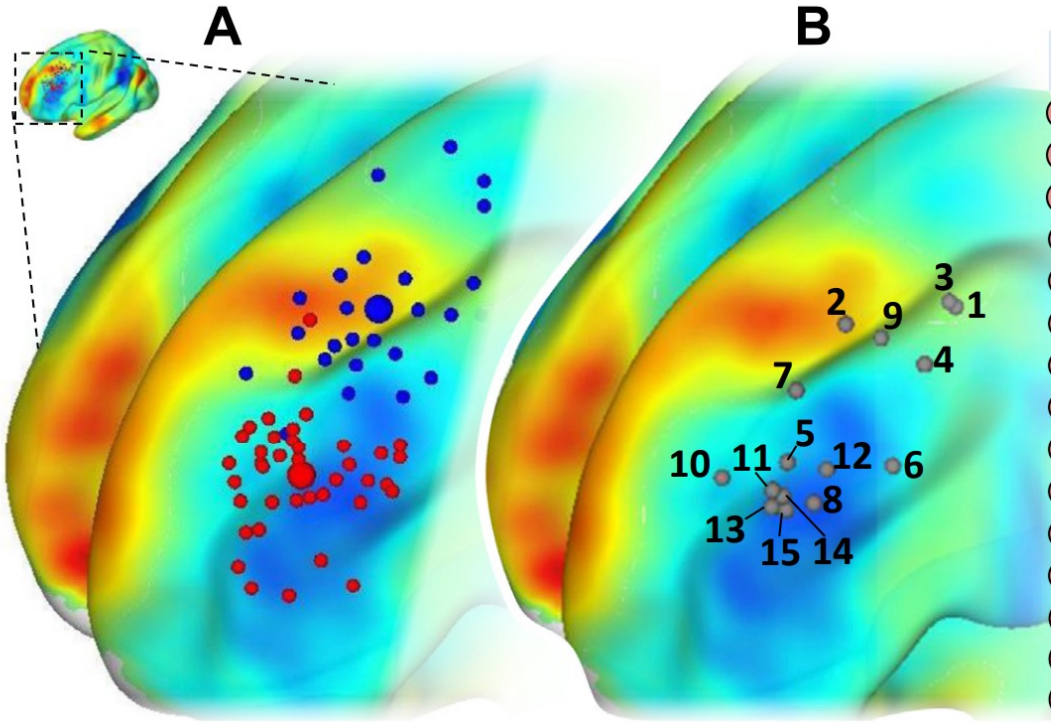


Review

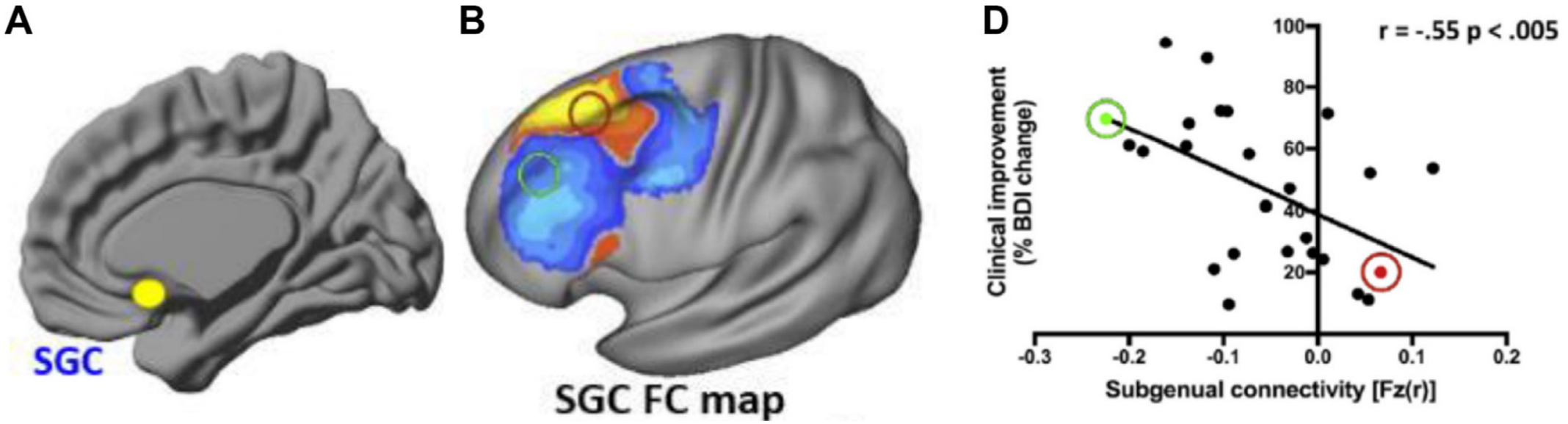
Biological Psychiatry

Using Brain Imaging to Improve Spatial Targeting of Transcranial Magnetic Stimulation for Depression

Robin F.H. Cash, Anne Weigand, Andrew Zalesky, Shan H. Siddiqi, Jonathan Downar, Paul B. Fitzgerald, and Michael D. Fox



	Target	x	y	z
1	5cm average (Fox et al., 2012) (6)	-41	16	54
2	5.5cm average (Weigand et al., 2018) (7)	-33	30	50
3	Non-responders (Herbsman et al., 2009) (13)	-41	17	55
4	Responders (Herbsman et al., 2009) (13)	-46	23	49
5	TMS Target (Fitzgerald et al., 2009) (22)	-46	45	38
6	TMS Target (Rusjan et al., 2010) (47)	-50	30	36
7	BA9 Definition (Rajkowska et al., 1995) (45)	-36	39	43
8	BA46 Definition (Rajkowska et al., 1995) (45)	-44	40	29
9	EEG F3 site (Herwig et al., 2003) (14)	-37	26	49
10	EEG F3 site (Okamotu et al., 2004) (158)	-43	58	40
11	Beam F3 (Cash et al., 2019) (5)	-43	46	32
12	Optimal FC Group Target #1 (Fox et al., 2012, N=98) (6)	-44	38	34
13	Optimal FC Group Target #2 (Fox et al., 2012, N=98) (6)	-38	44	26
14	Optimal FC Group Target (Weigand et al., 2018, N=1000) (7)	-42	44	30
15	Optimal FC Group Target (Cash et al., 2019, N=2000) (104)	-41	43	27

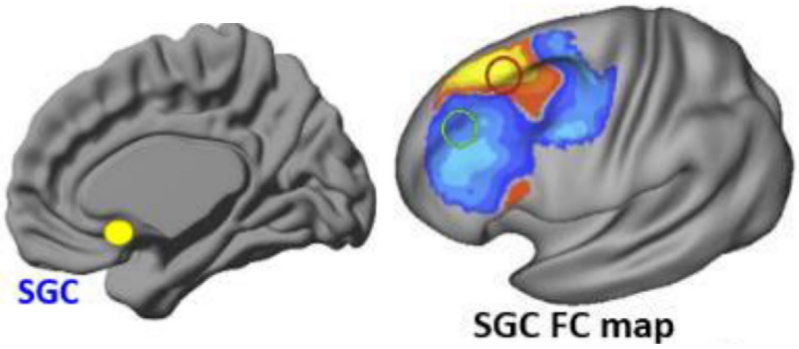


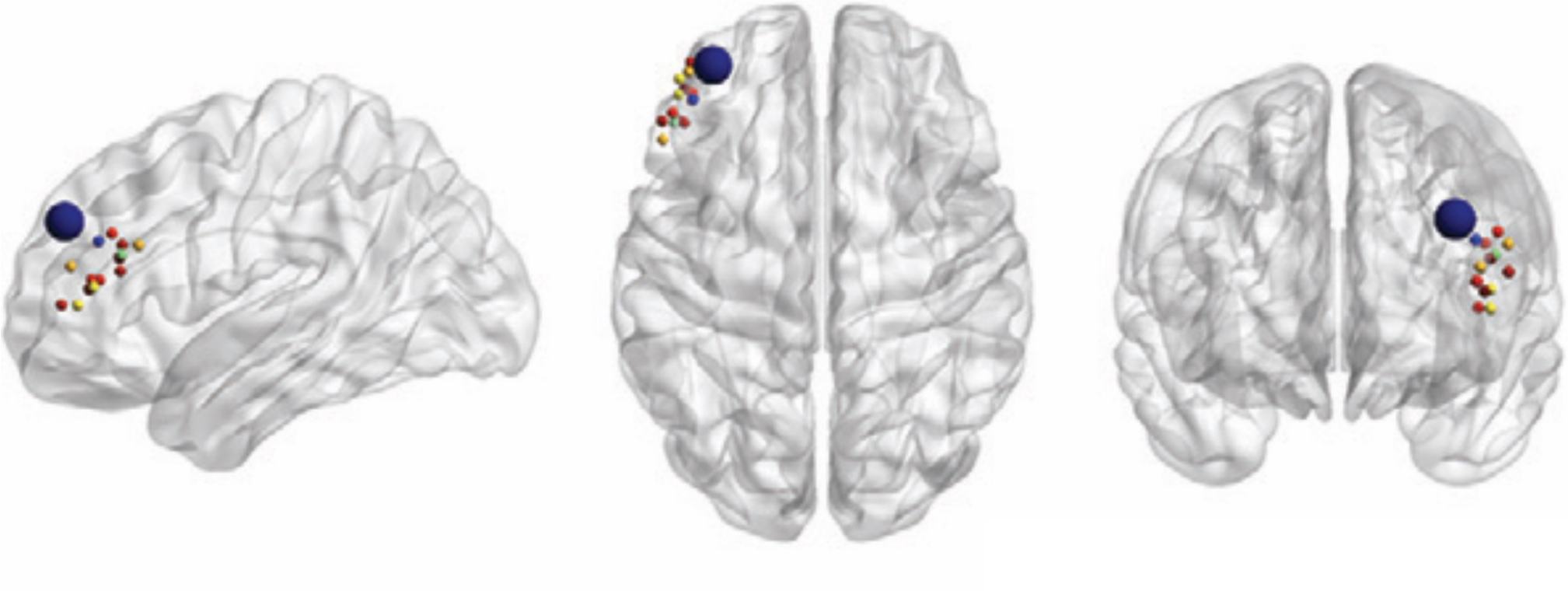
Biological Psychiatry November 15, 2021; 90:689–700

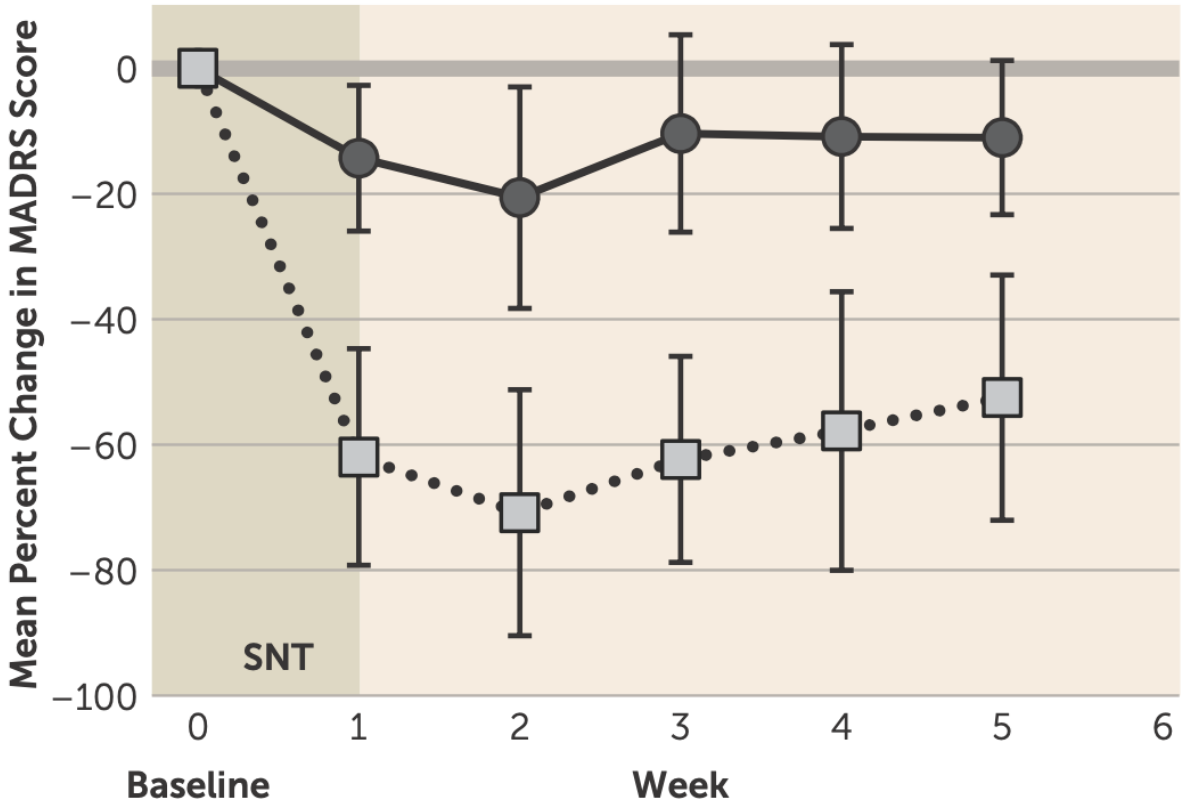
Stanford Neuromodulation Therapy (SNT): A Double-Blind Randomized Controlled Trial

Eleanor J. Cole, Ph.D., Angela L. Phillips, Ph.D., Brandon S. Bentzley, M.D., Ph.D., Katy H. Stimpson, B.S., Romina Nejad, M.S., Fahim Barmak, M.D., Clive Veerapal, B.S., Naushaba Khan, B.S., Kirsten Cherian, Ph.D., Emily Felber, M.S., Randi Brown, M.S., Elizabeth Choi, M.S., Sinead King, Ph.D., Heather Pankow, B.S., James H. Bishop, Ph.D., Azeezat Azeez, Ph.D., John Coetzee, Ph.D., Rachel Rapier, B.S., Nicole Odenwald, M.A., David Carreon, M.D., Jessica Hawkins, B.A., Maureen Chang, B.S., Jennifer Keller, Ph.D., Kristin Raj, M.D., Charles DeBattista, M.D., Booil Jo, Ph.D., Flint M. Espil, Ph.D., Alan F. Schatzberg, M.D., Keith D. Sudheimer, Ph.D., Nolan R. Williams, M.D.

Am J Psychiatry 179:2, February 2022


SGC
SGC FC map





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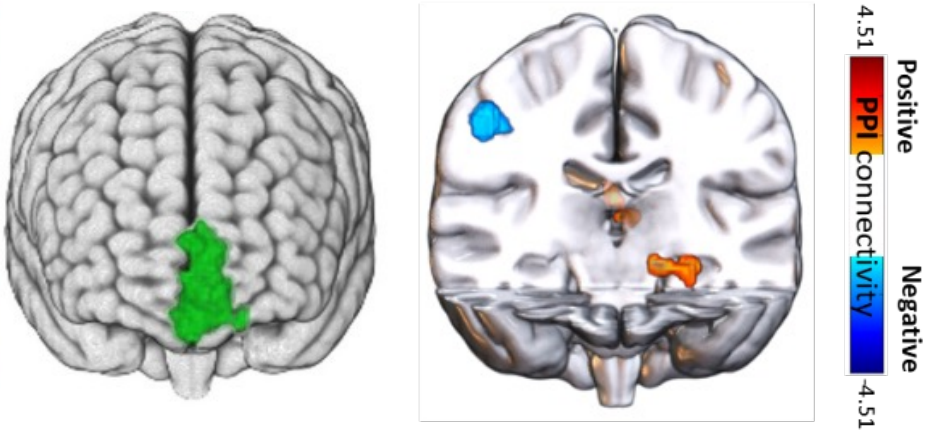
frontiers in PSYCHIATRY

ORIGINAL RESEARCH ARTICLE
published: 27 February 2014
doi: 10.3389/fpsyt.2014.00016

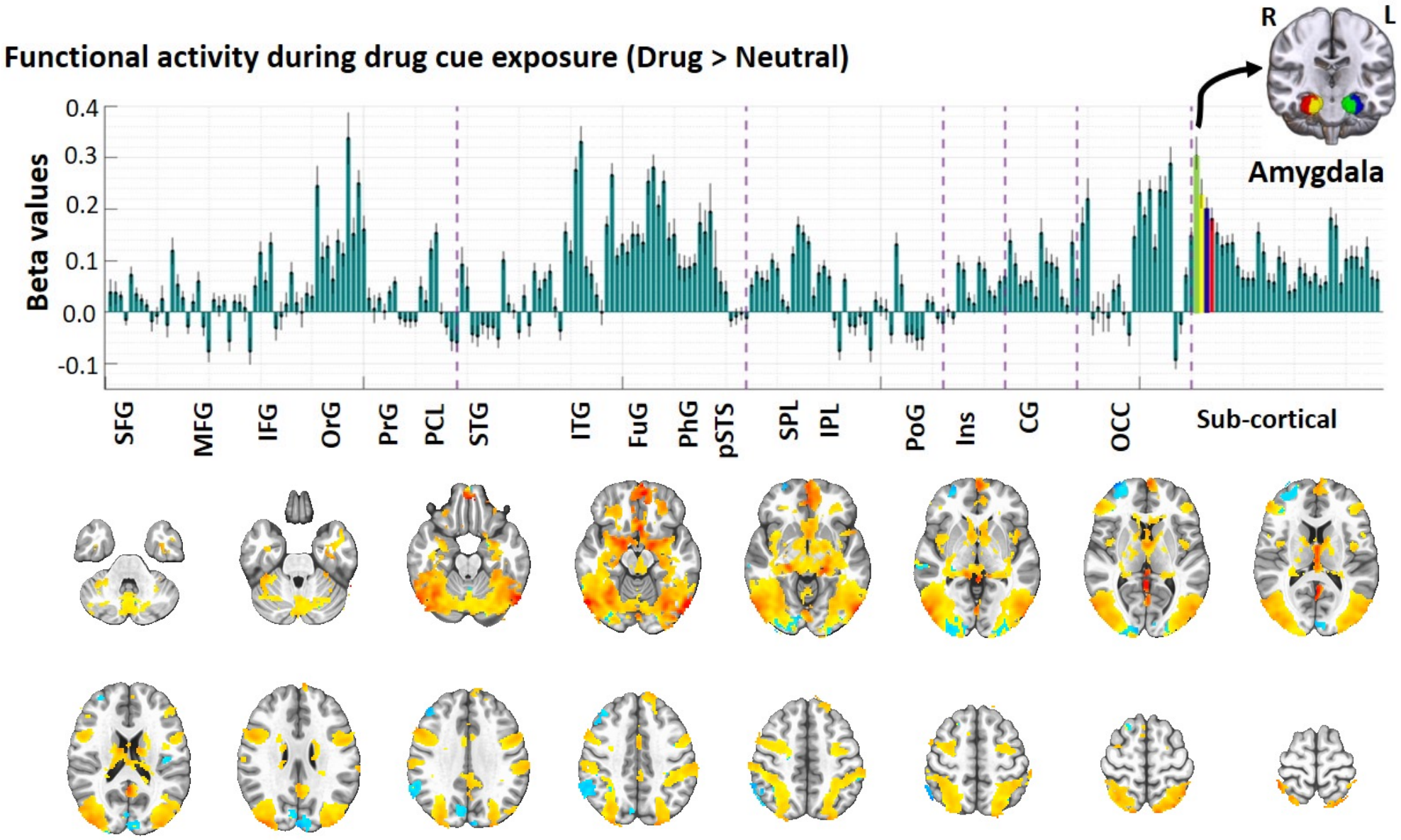
Cortico-amygdala coupling as a marker of early relapse risk in cocaine-addicted individuals

Meredith J. McHugh[1]*, Catherine H. Demers[1], Betty Jo Salmeron[1], Michael D. Devous Sr.[2], Elliot A. Stein[1]*† and Bryon Adinoff[3,4]†

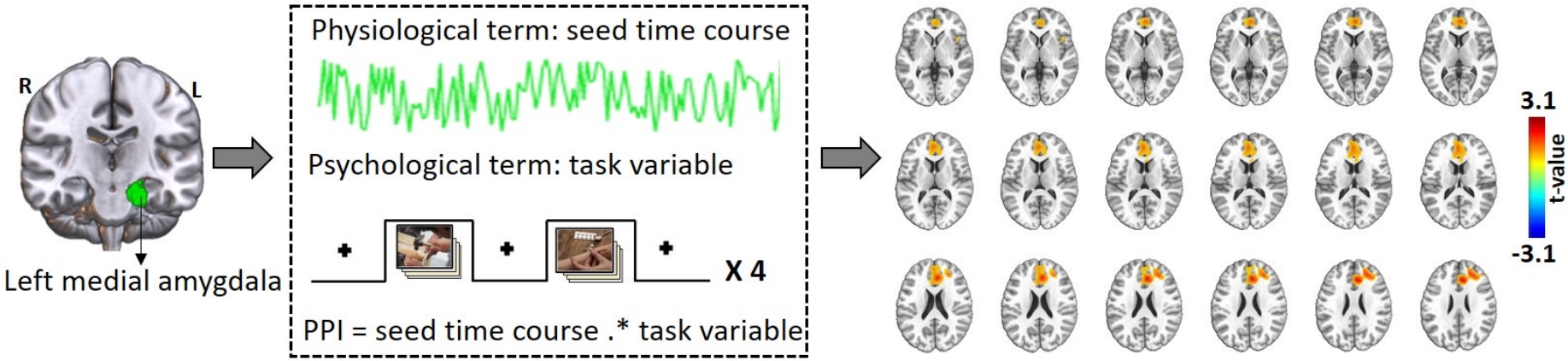
Cue Reactivity Connectivity



"rsFC between the left centromedial amygdala and ventromedial prefrontal cortex/ rostral anterior cingulate cortex predicts relapse"


Functional activity during drug cue exposure (Drug > Neutral)
R
L
Amygdala
Beta values
0.4
0.3
0.2
0.1
0.0
-0.1
SFG
MFG
IFG
OrG
PrG
PCL
STG
ITG
FuG
PhG
pSTS
SPL
IPL
PoG
Ins
CG
OCC
Sub-cortical

a. Seed-to-whole brain PPI analysis by considering left medial amygdala as the seed region



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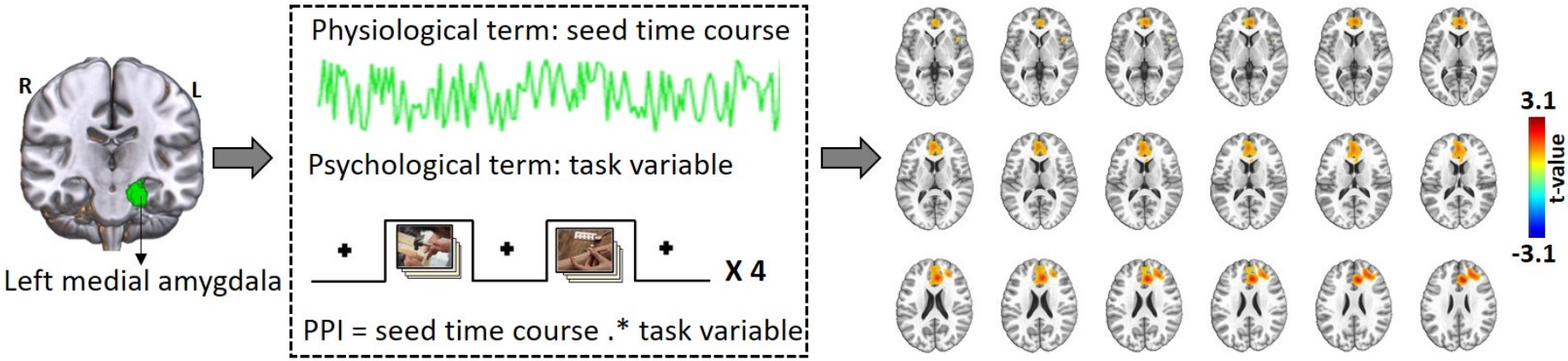
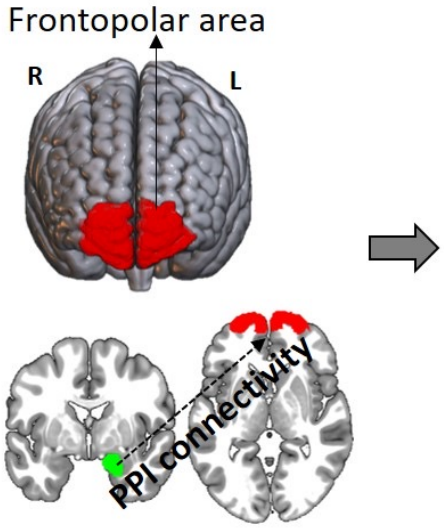


b. MNI coordinate and cortical location of the voxel with maximum positive PPI strength



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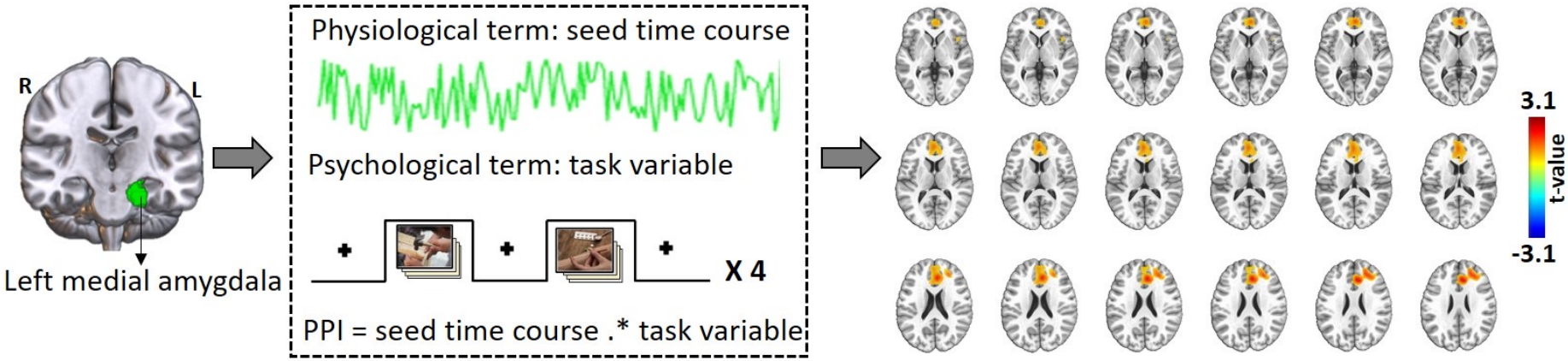

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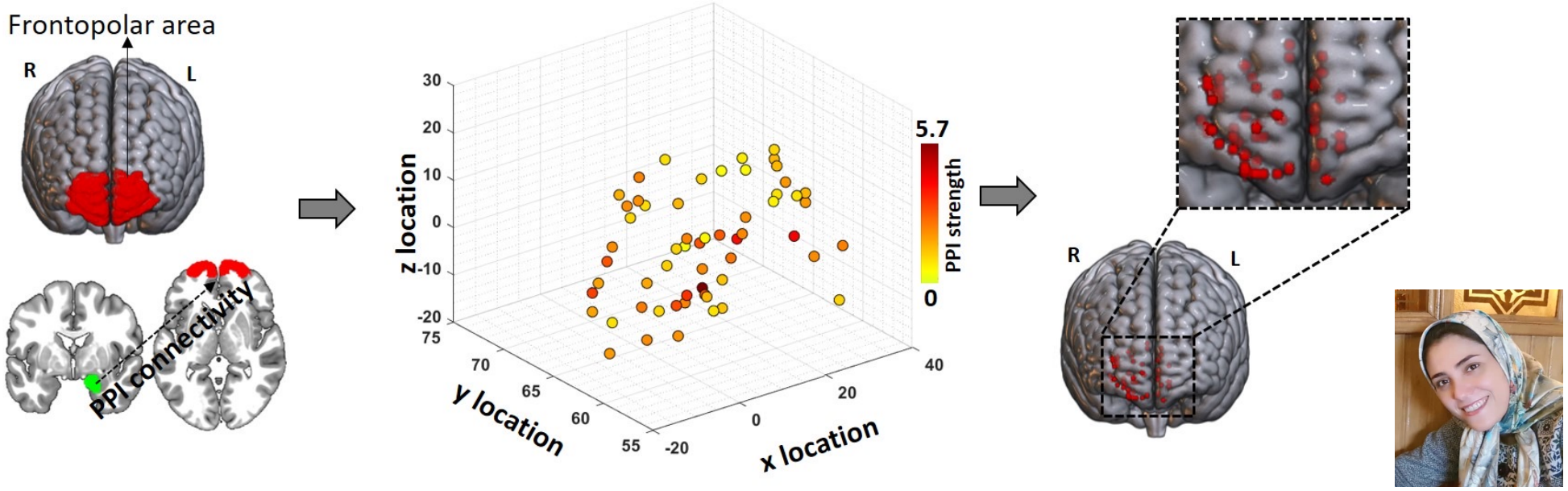
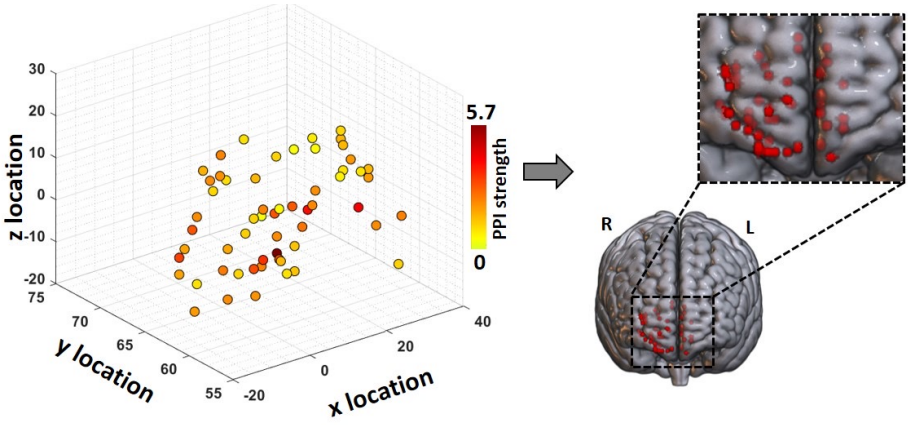
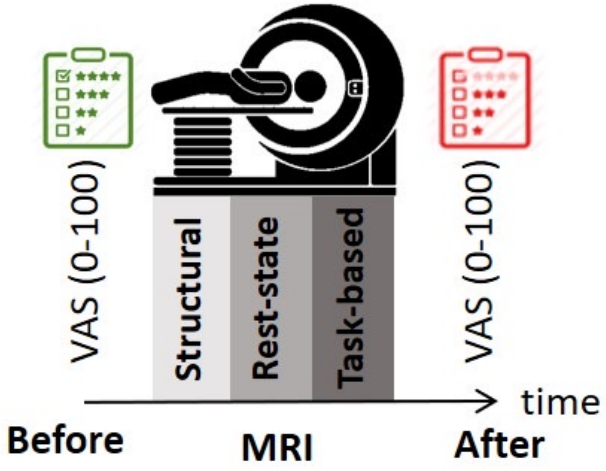
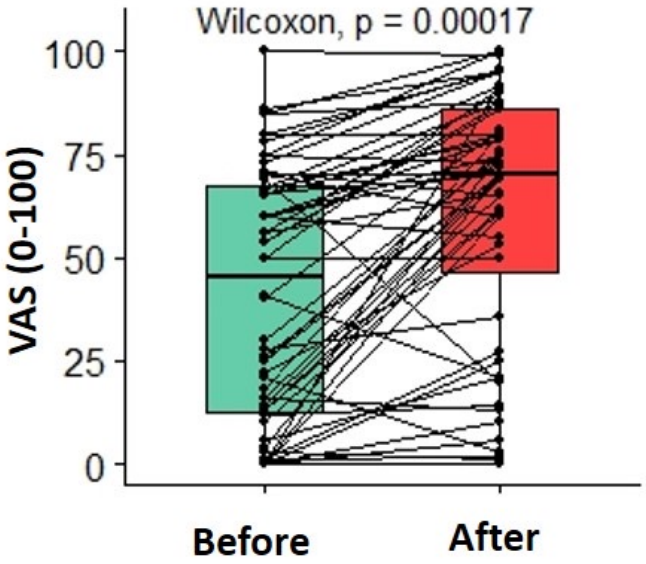




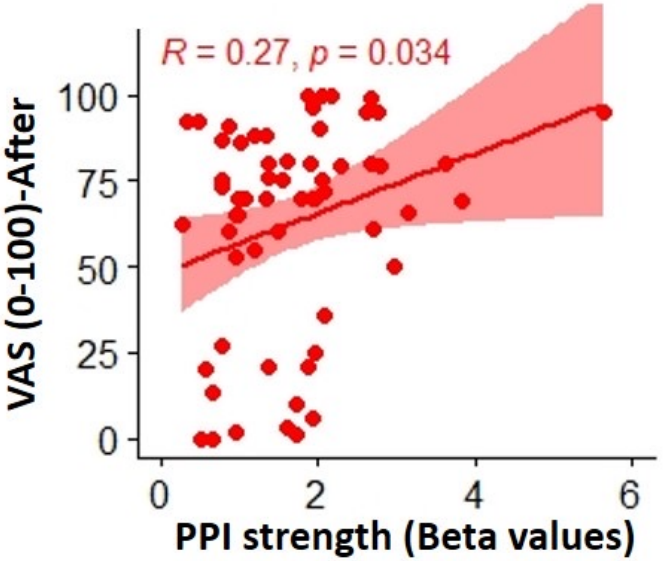
a. Data acquisition procedure



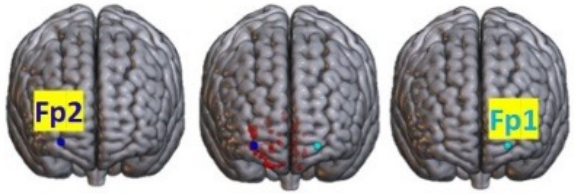
b. Cue induced craving (VAS)



c. Correlation between VAS and PPI

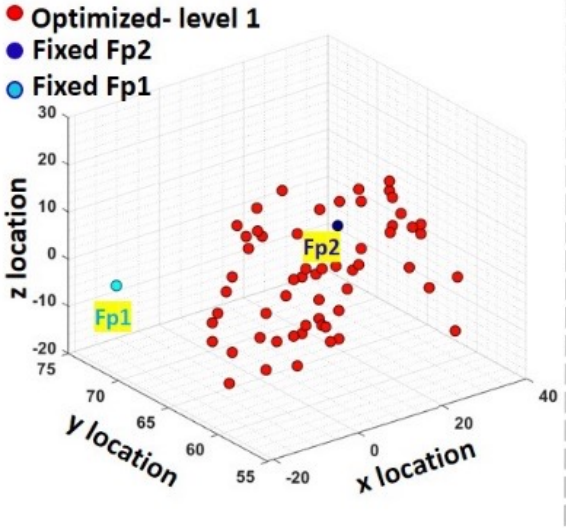


a1. Level 1: Location

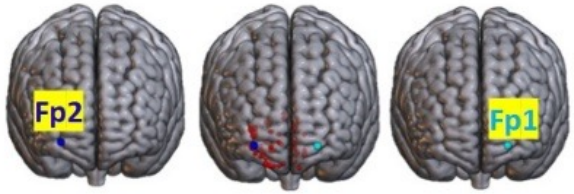


Fixed coil location (Fp2) | Individualized coil location | Fixed coil location (Fp1)

a2. MNI coordinate of targets

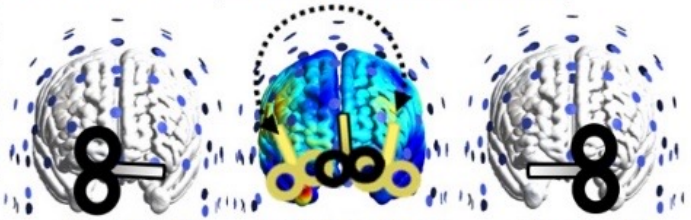


a1. Level 1: Location



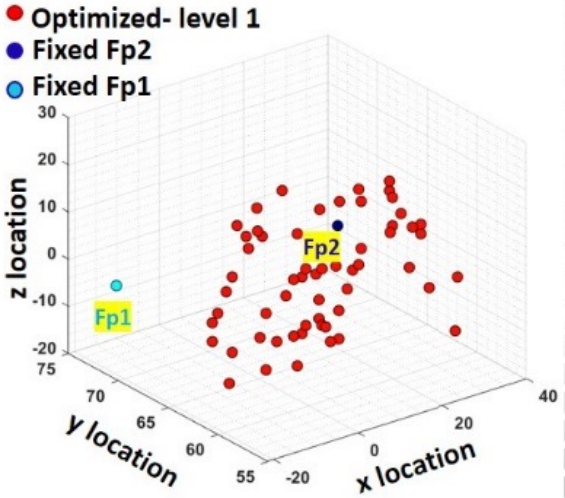
Fixed coil location (Fp2) | Individualized coil location | Fixed coil location (Fp1)

b1. Level 2: Location + Orientation

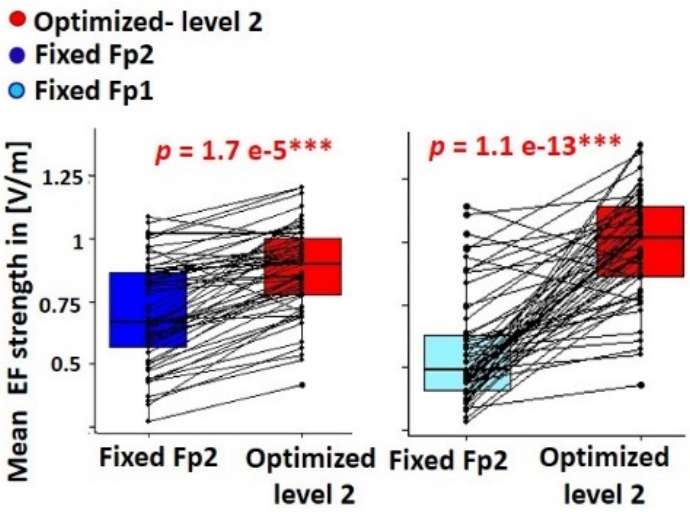


Fixed coil location (Fp2) + orientation (AF8) | Individualized coil location + orientation | Fixed coil location (Fp1) + orientation (AF7)

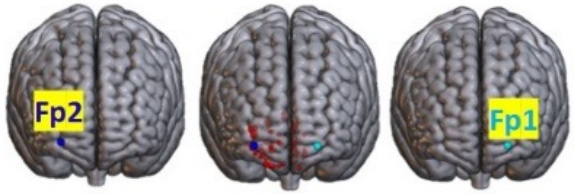
a2. MNI coordinate of targets



b2. EF strength around TMS targets

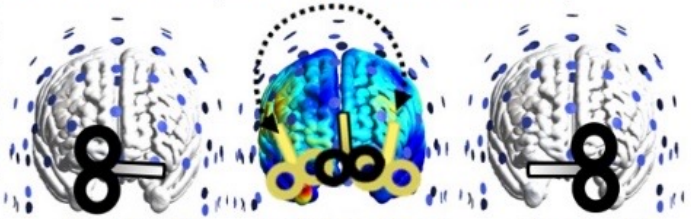


a1. Level 1: Location



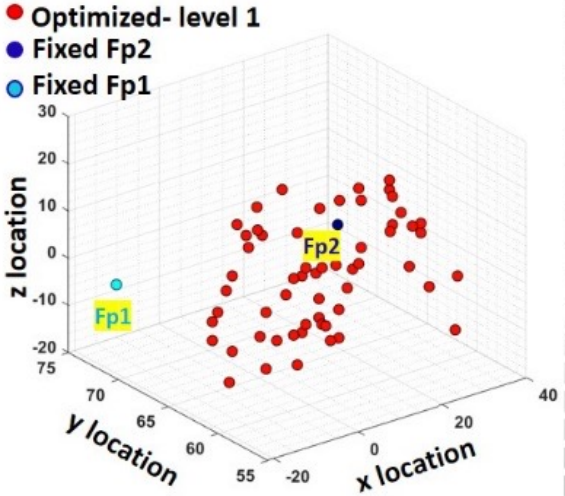
Fixed coil location (Fp2) | Individualized coil location | Fixed coil location (Fp1)

b1. Level 2: Location + Orientation

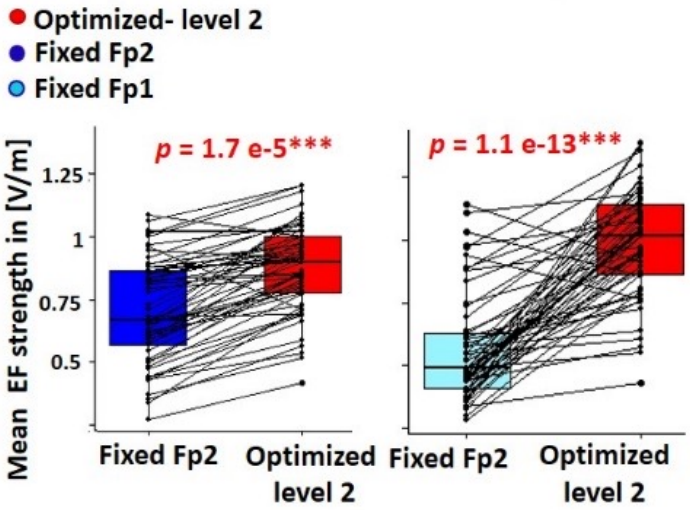


Fixed coil location (Fp2) + orientation (AF8) | Individualized coil location + orientation | Fixed coil location (Fp1) + orientation (AF7)

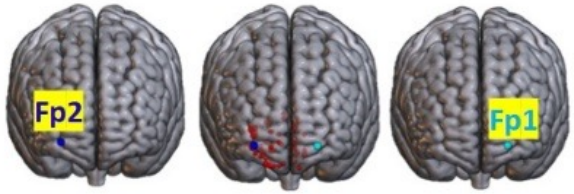
a2. MNI coordinate of targets



b2. EF strength around TMS targets

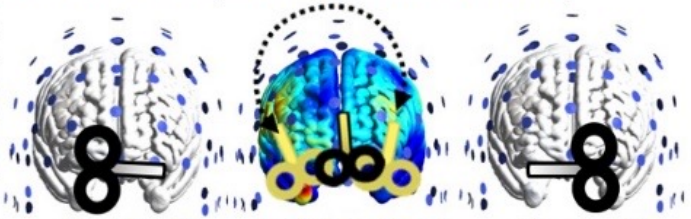


a1. Level 1: Location



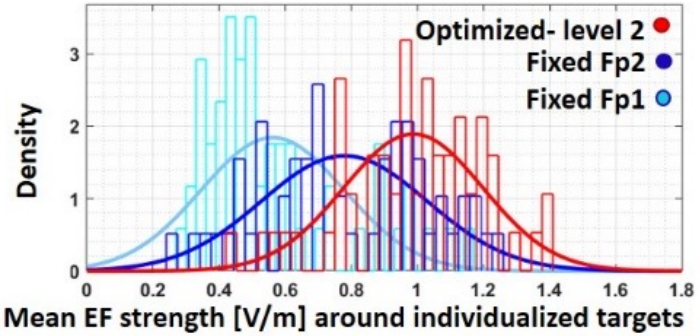
Fixed coil location (Fp2) | Individualized coil location | Fixed coil location (Fp1)

b1. Level 2: Location + Orientation

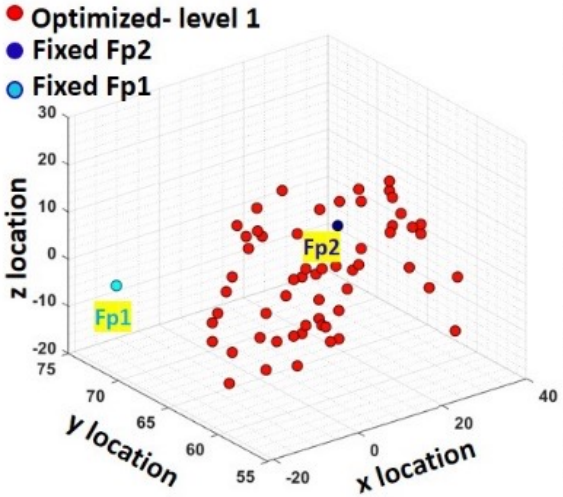


Fixed coil location (Fp2) + orientation (AF8) | Individualized coil location + orientation | Fixed coil location (Fp1) + orientation (AF7)

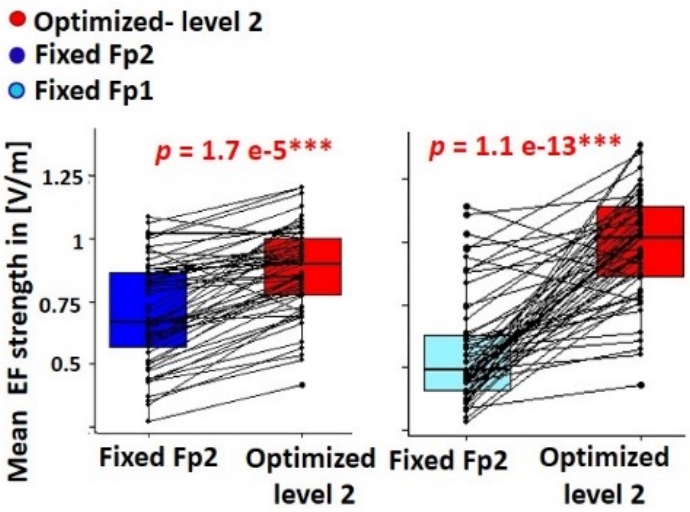
c1. Level 3: Location + Orientation + Intensity



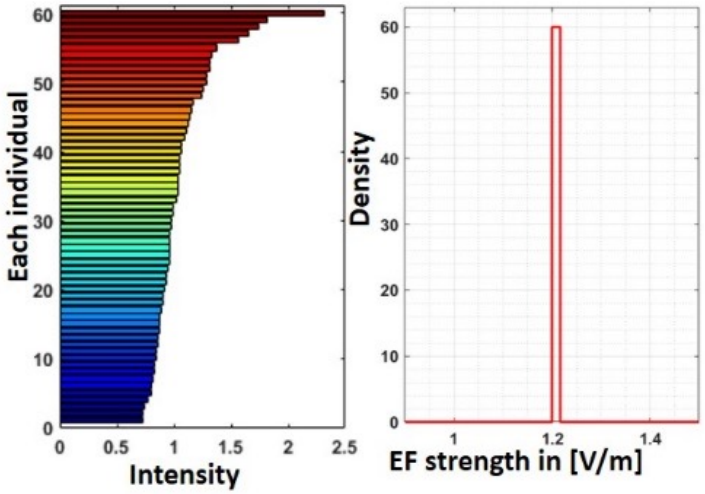
a2. MNI coordinate of targets



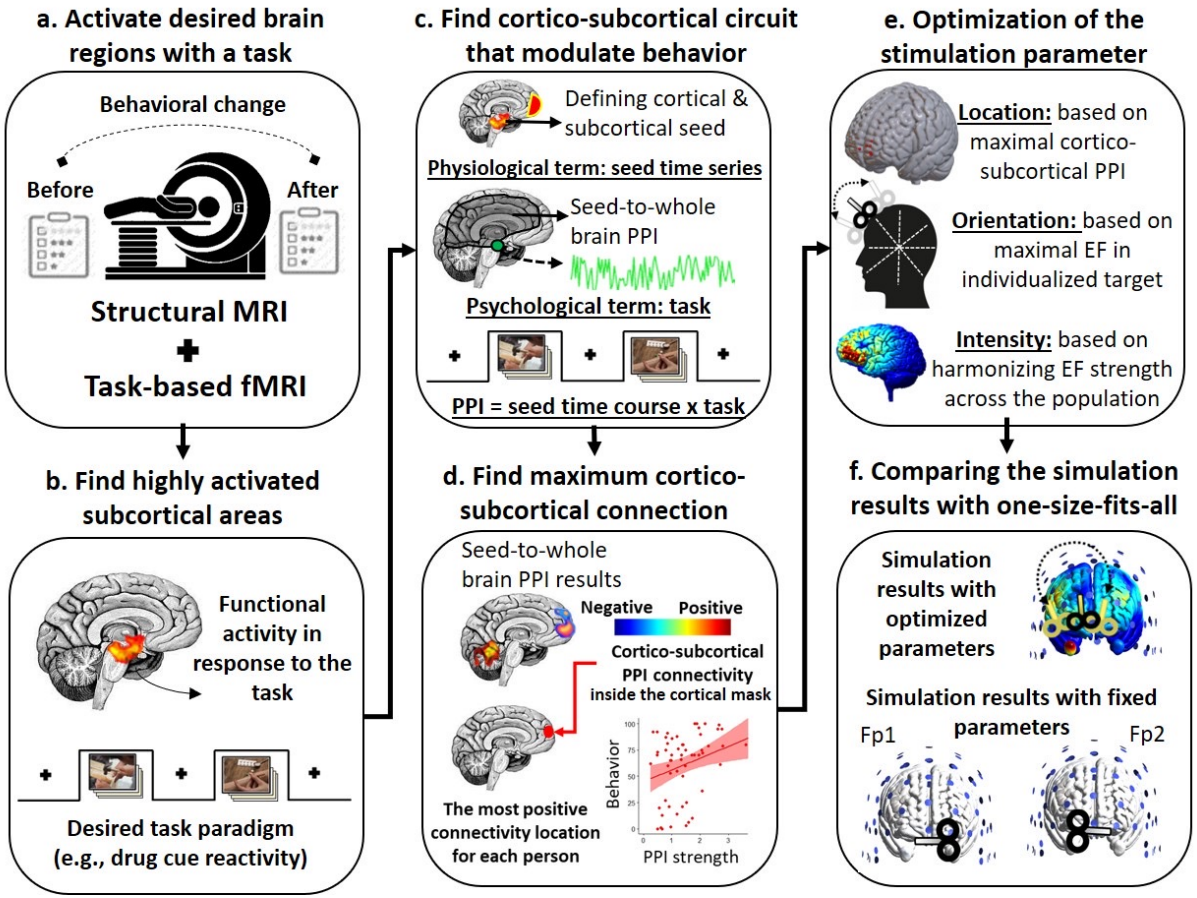
b2. EF strength around TMS targets



c2. Individualized intensity adjustment



Proposed Pipeline for Individualization



Optimizing Individual Targeting of Fronto-Amygdala Network with Transcranial Magnetic Stimulation (TMS): Biophysical, Physiological and Behavioral Variations in People with Methamphetamine Use Disorder

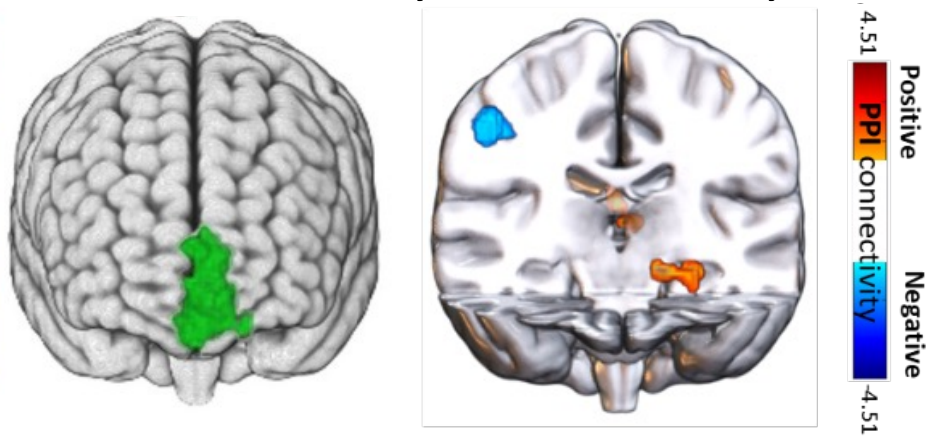
Ghazaleh Soleimani, Christine Conelea, Rayus Kuplicki, Alexander Opitz, Kelvin O Lim, Martin P. Paulus, Hamed Ekhtiari

doi: https://doi.org/10.1101/2023.04.02.23288047

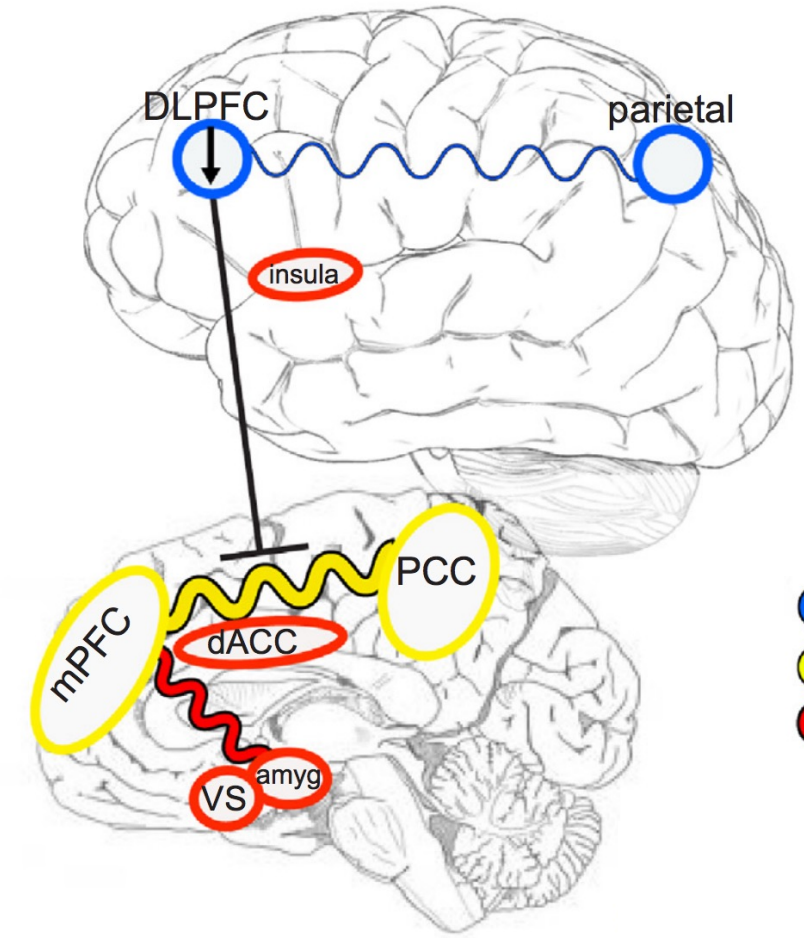
SCAN ME

DLPFC as a Target

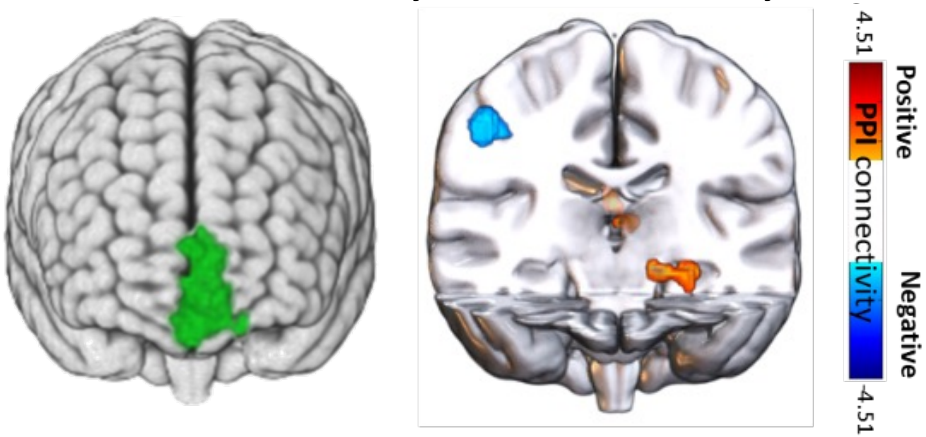
Cue Reactivity Connectivity



Top-Down Regulation



Cue Reactivity Connectivity

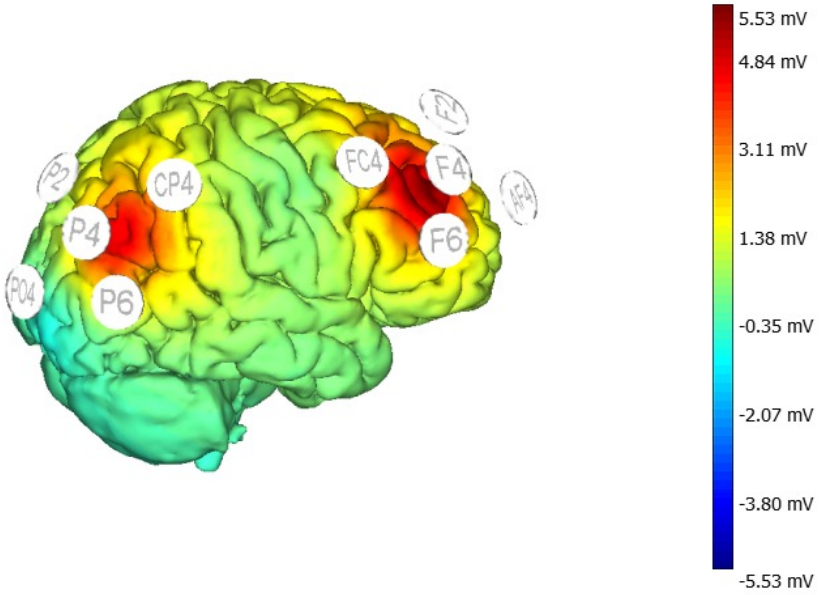


Frontoparietal network
Default mode network
Affective salience network

Fischer, et al., Biological Psychiatry: Cognitive Neuroscience and Neuroimaging May 2016; 1:262–270 www.sobp.org/BPCNNI

Frontoparietal Stimulation

With Transcranial Alternating Current Stimulation (tACS)



Ghazaleh Soleimani

a. HD electrode configuration

b. EF simulation in subject space

c. EF transformation to the MNI space

Anode over F3

Anode over F4

L

R

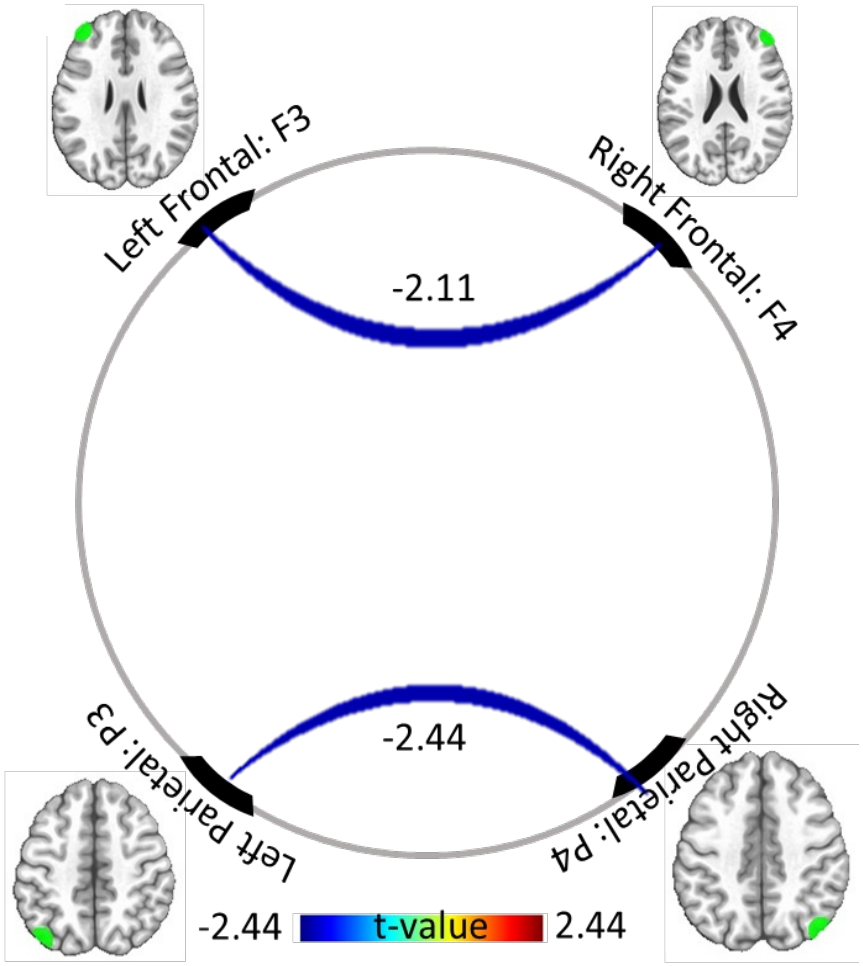
d. Frontal seed definition

10 mm sphere around the maximum EF

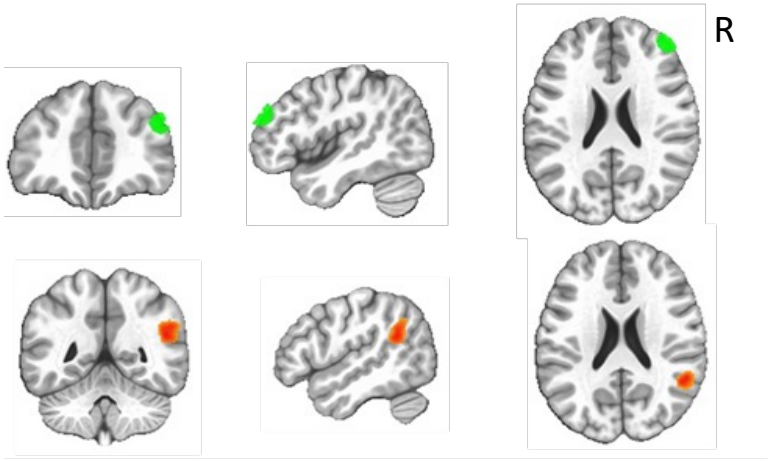
Anode over P3

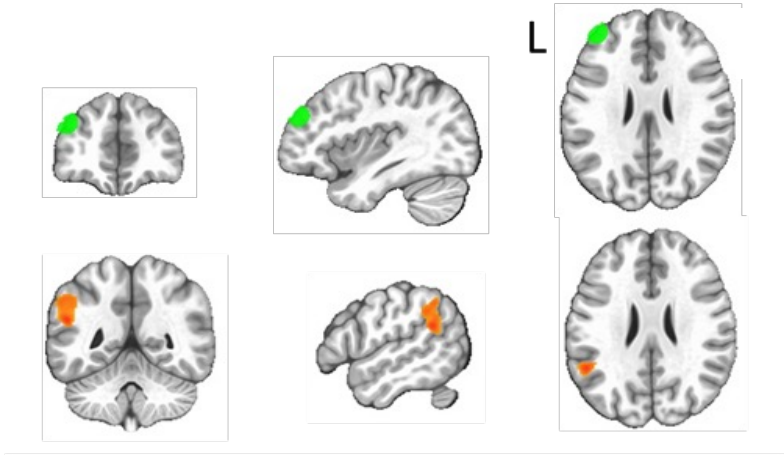
Anode over P4

Drug Cue Reactivity Task-based Connectivity (PPI)

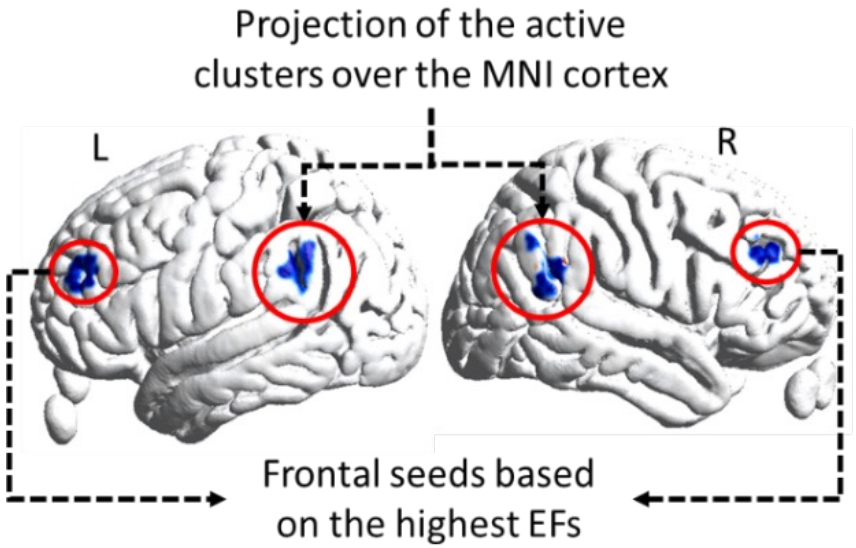


RoI to Whole Brain Task-based Connectivity (PPI)

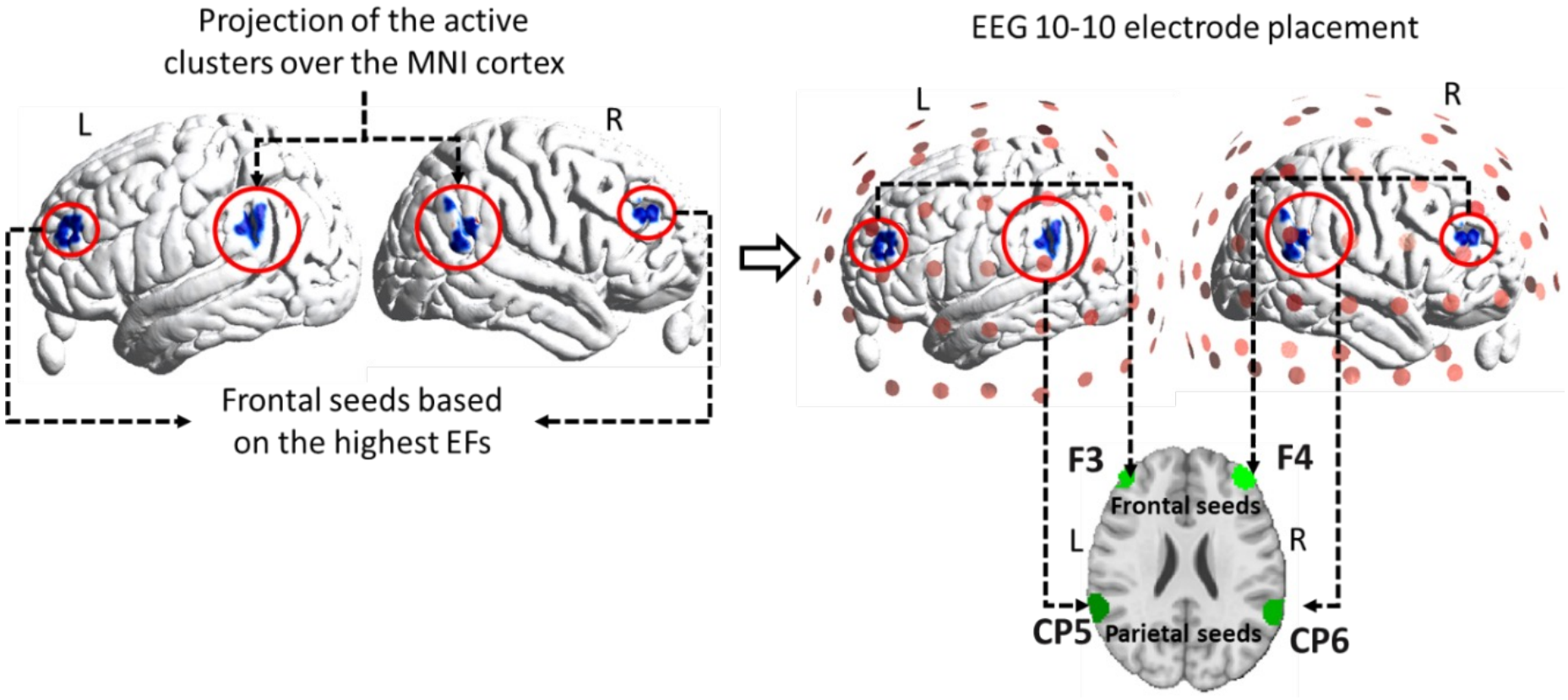




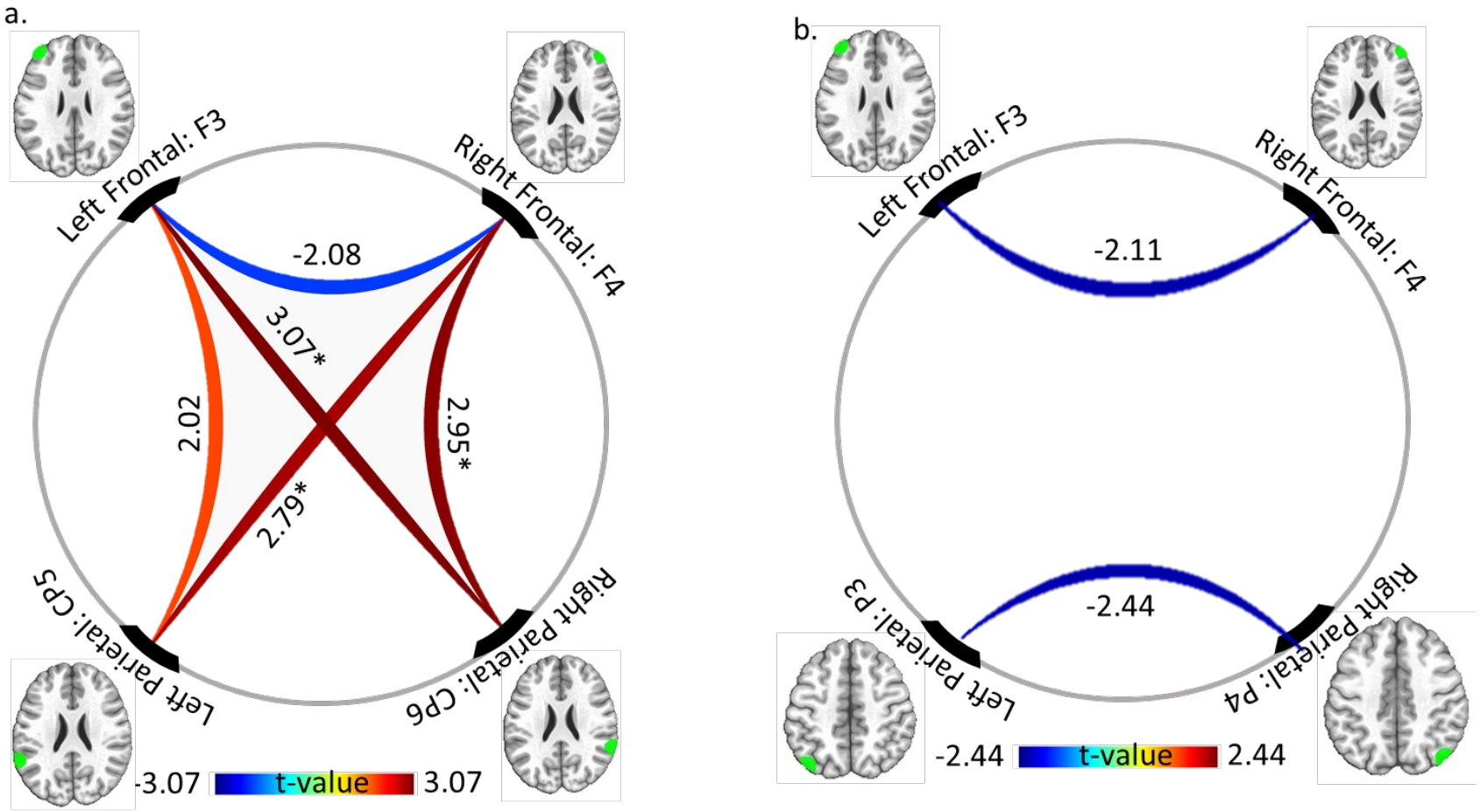
Electrode Placement for the Parietal Node



Electrode Placement for the Parietal Node



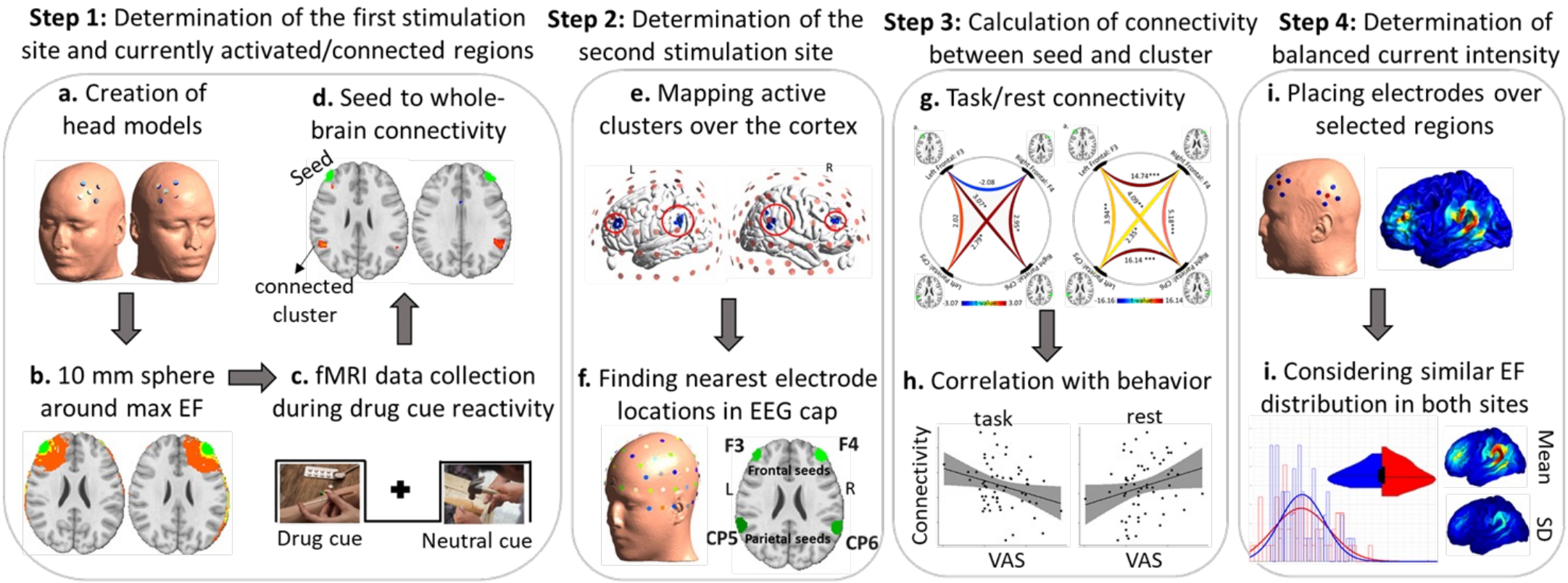
RoI to RoI Task-based fMRI Connectivity



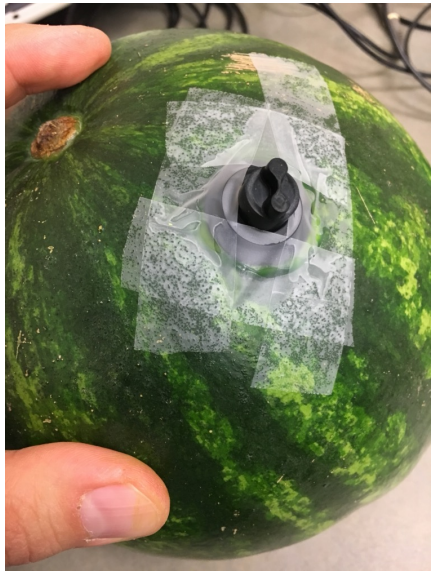
BRAIN STIMULATION

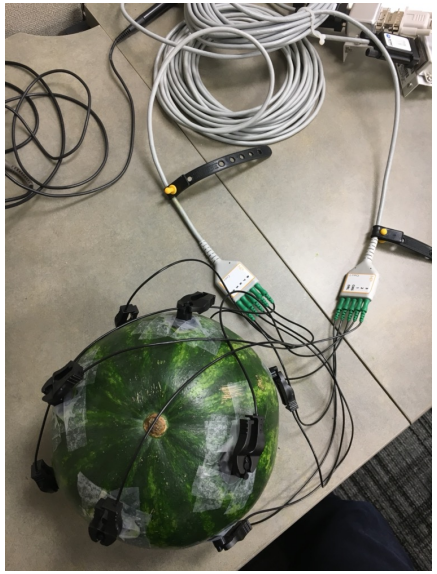
How structural and functional MRI can inform dual-site tACS parameters: A case study in a clinical population and its pragmatic implications

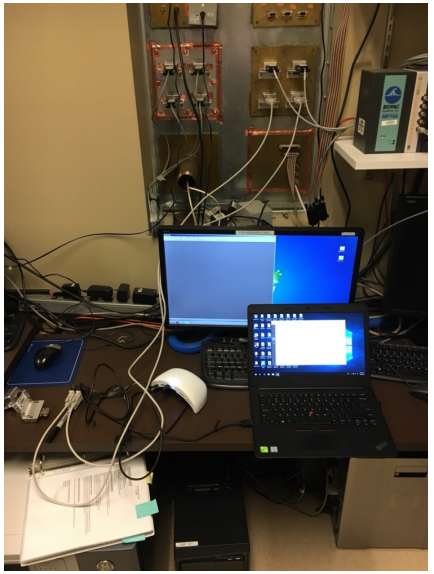
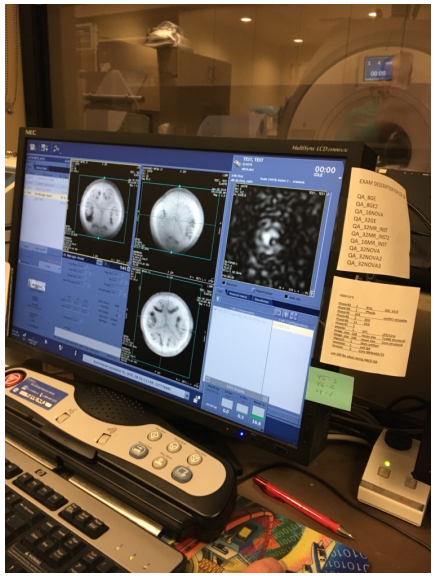
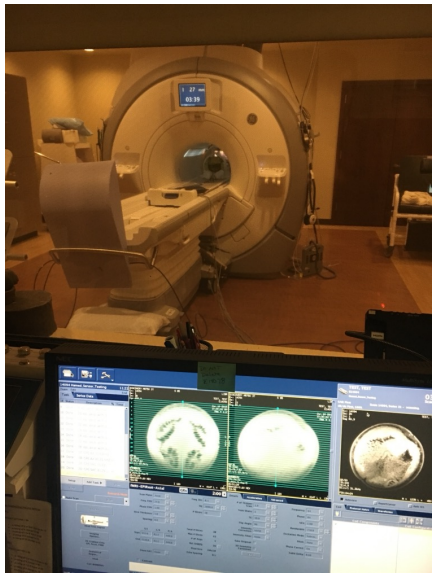
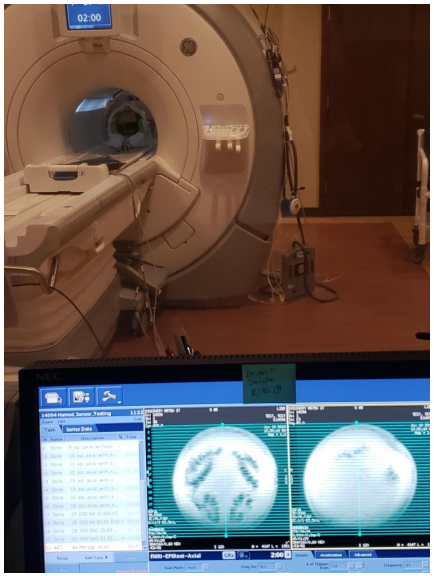
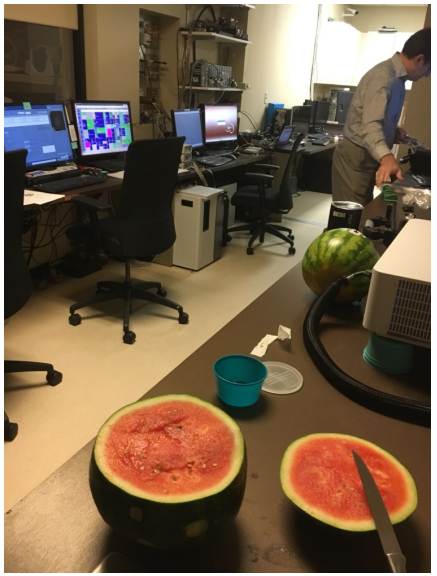
Ghazaleh Soleimani [b, c], Rayus Kupliki [a], Jerzy Bodurka [a], Martin P. Paulus [a], Hamed Ekhtiari [a]

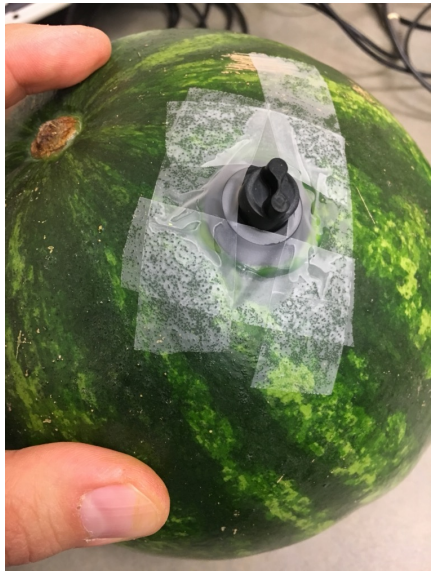


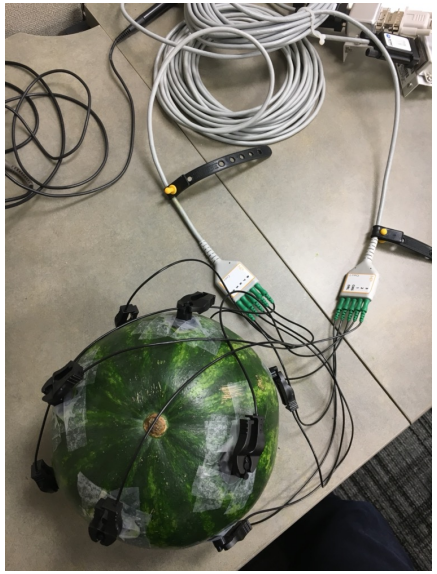
How to Optimize Stimulation in the Individual Level?

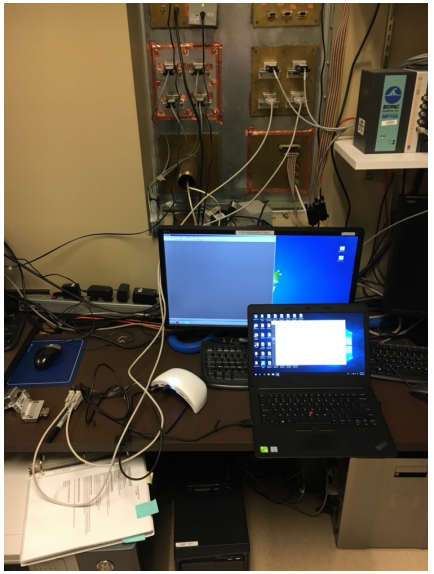
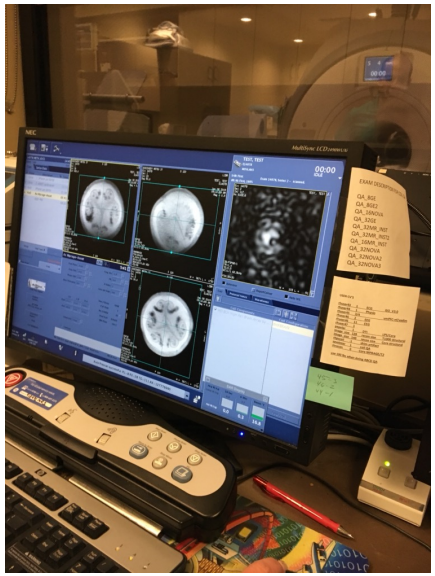
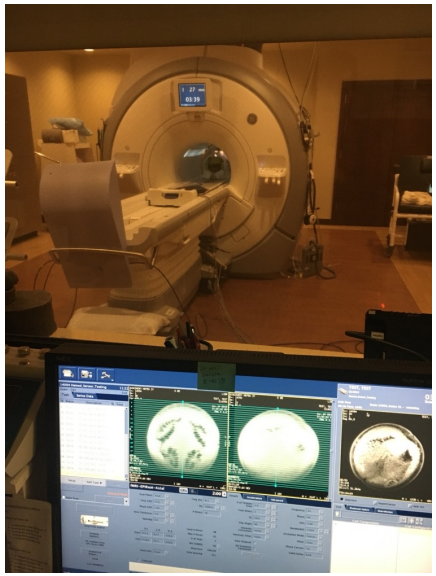
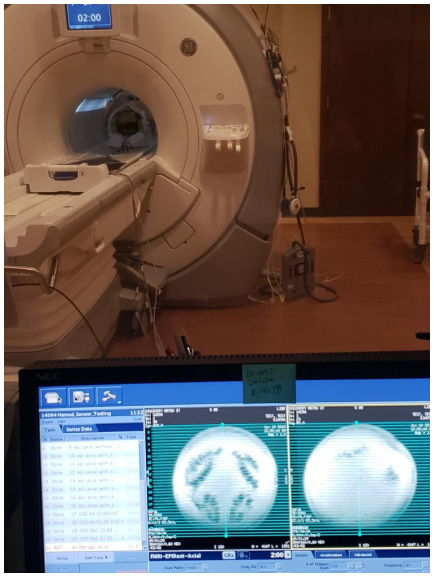


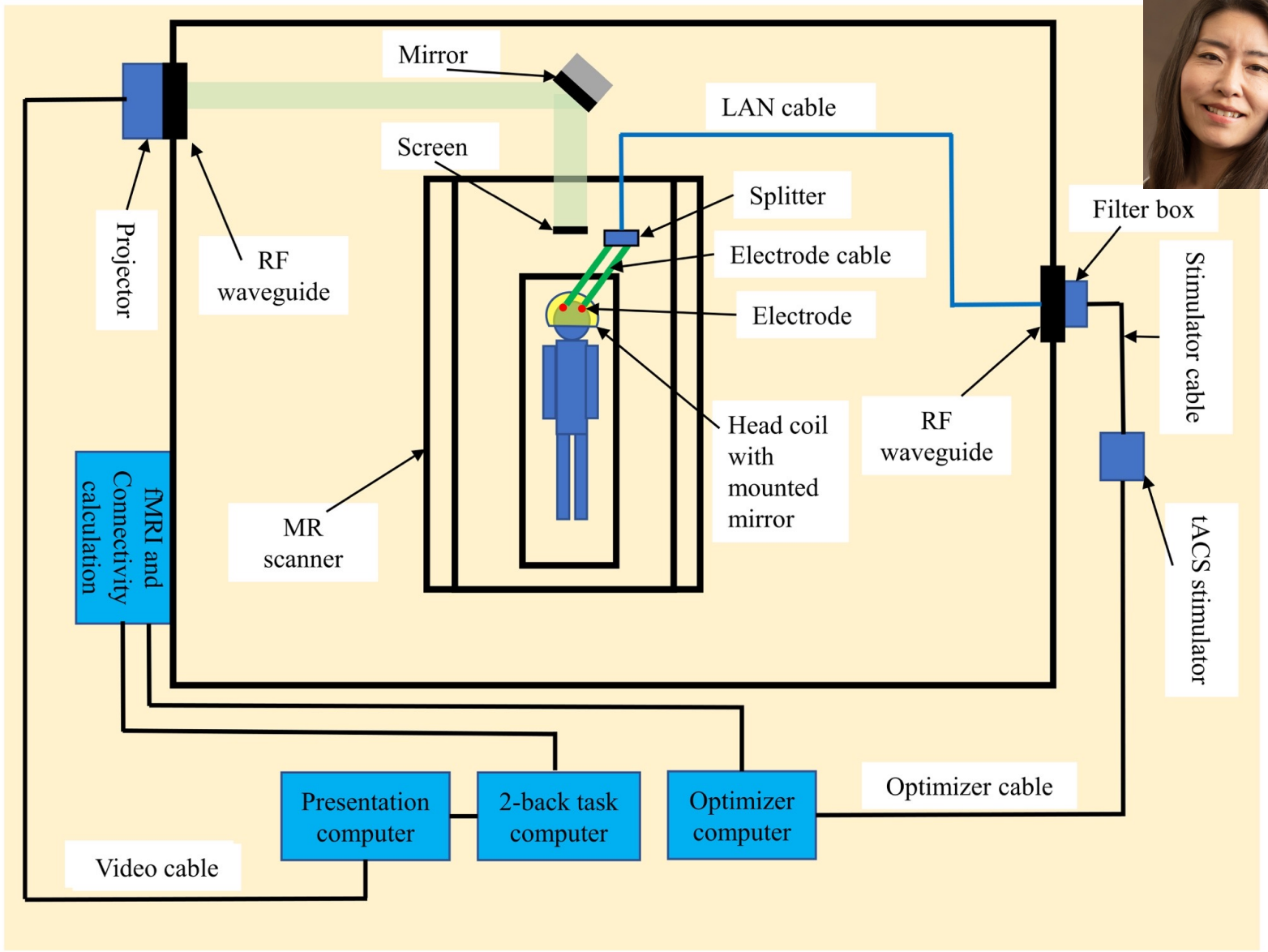


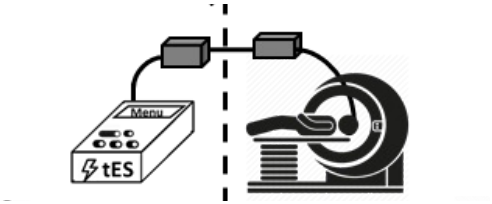






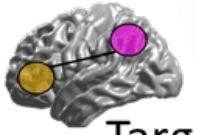





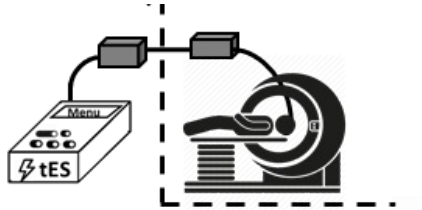


Mirror
LAN cable
Screen
Splitter
Filter box
Projector
RF waveguide
Electrode cable
Stimulator cable
Electrode
RF waveguide
Head coil with mounted mirror
fMRI and Connectivity calculation
MR scanner
tACS stimulator
Presentation computer
2-back task computer
Optimizer computer
Optimizer cable
Video cable



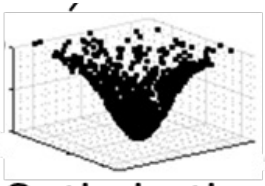


Target engagement measure

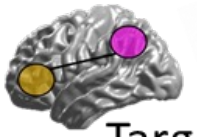
Target engagement (level of target modulation)



Parameter adjustment



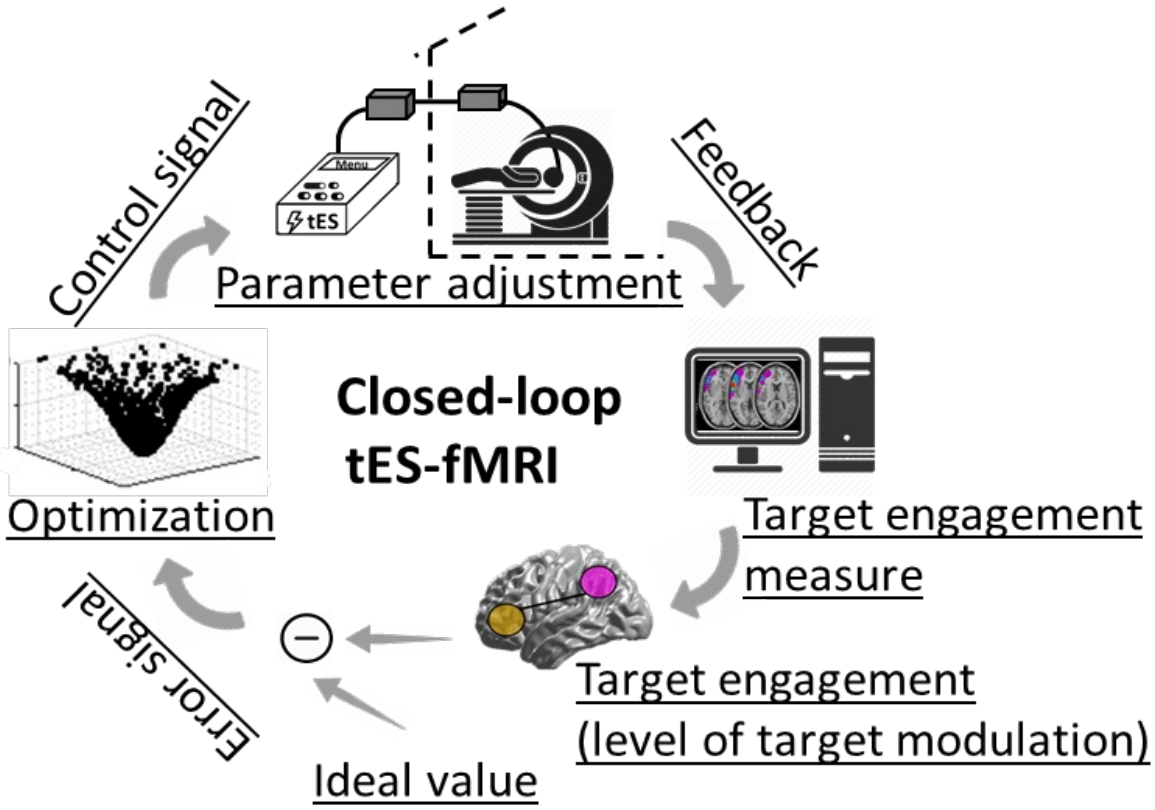
Optimization



Target engagement measure

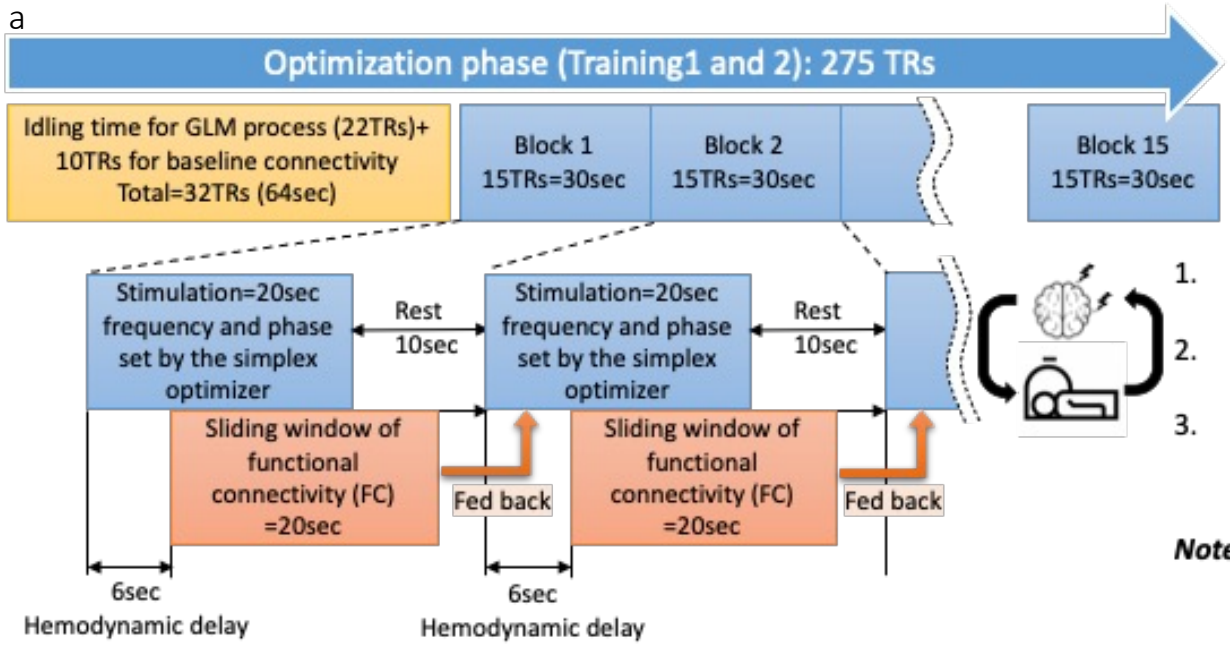
Target engagement (level of target modulation)

Closed Loop tES fMRI



(Soleimani, et al., under review)

a



1. Real-time calculation of FC within executive control network (under F4 and P4) is conducted and is fed back to the optimizer.
2. The optimizer searches through the parameters based on the real-time FC to maximize its value.
3. The optimizer keep searching the **parameters to maximize FC values in the optimized group**, while the optimizer keep searching the **parameters to minimize FC values in the non-optimized group**.

Note. GLM: generalized linear model, TR: time repetition

b

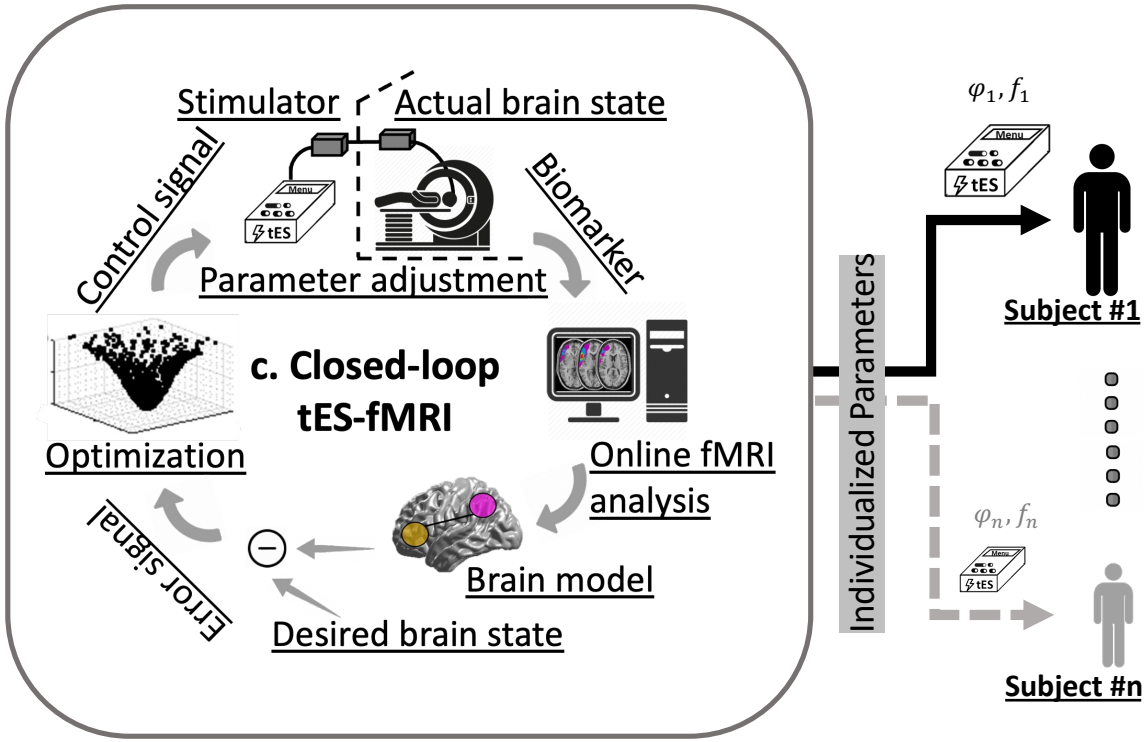
Online Closed-Loop Real-Time tES-fMRI for Brain Modulation: Feasibility, Noise/Safety and Pilot Study

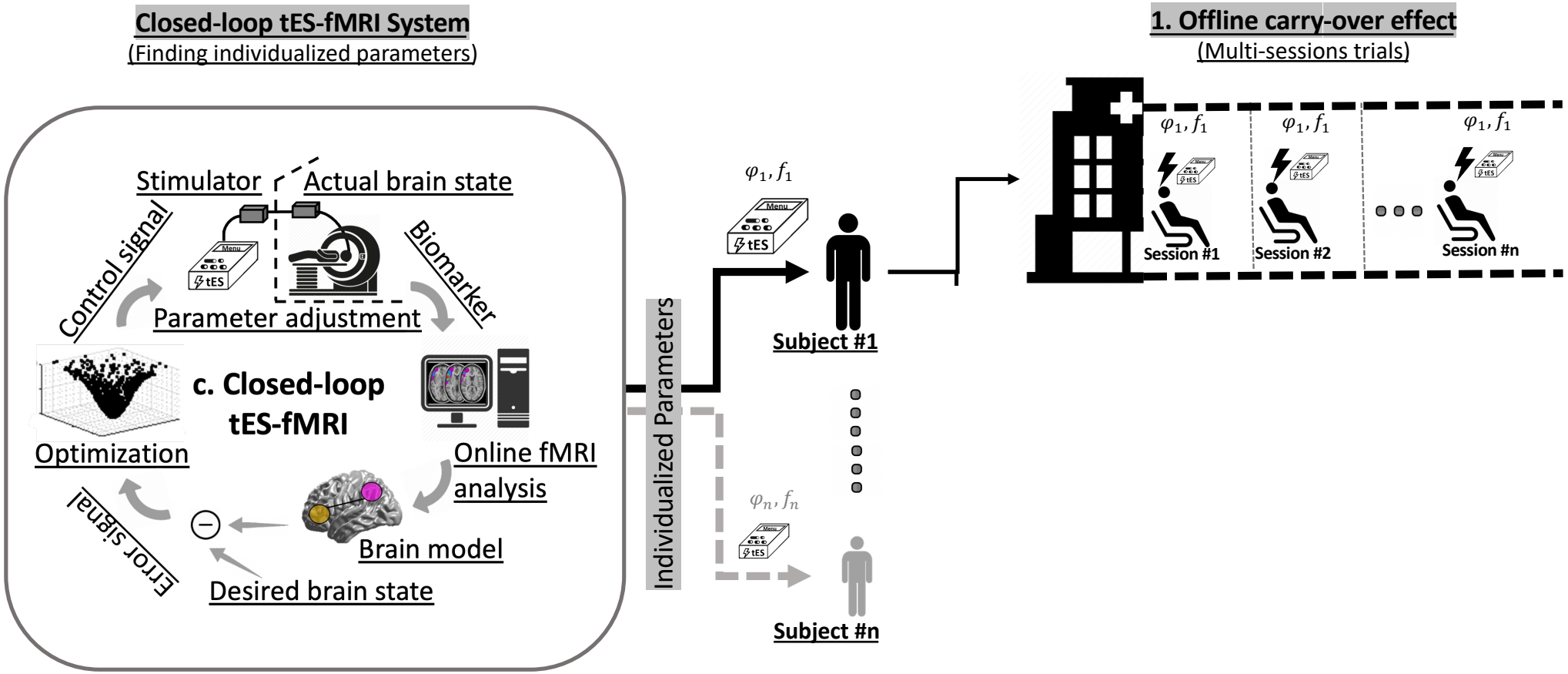
Beni Mulyana, Aki Tsuchiyagaito, Jared Smith, Masaya Misaki, Rayus Kuplicki, Ghazaleh Ashkan Rashedi, Duke Shereen, Til Ole Bergman, Samuel Cheng, Martin Paulus, Jerzy Hamed Ekhtiari

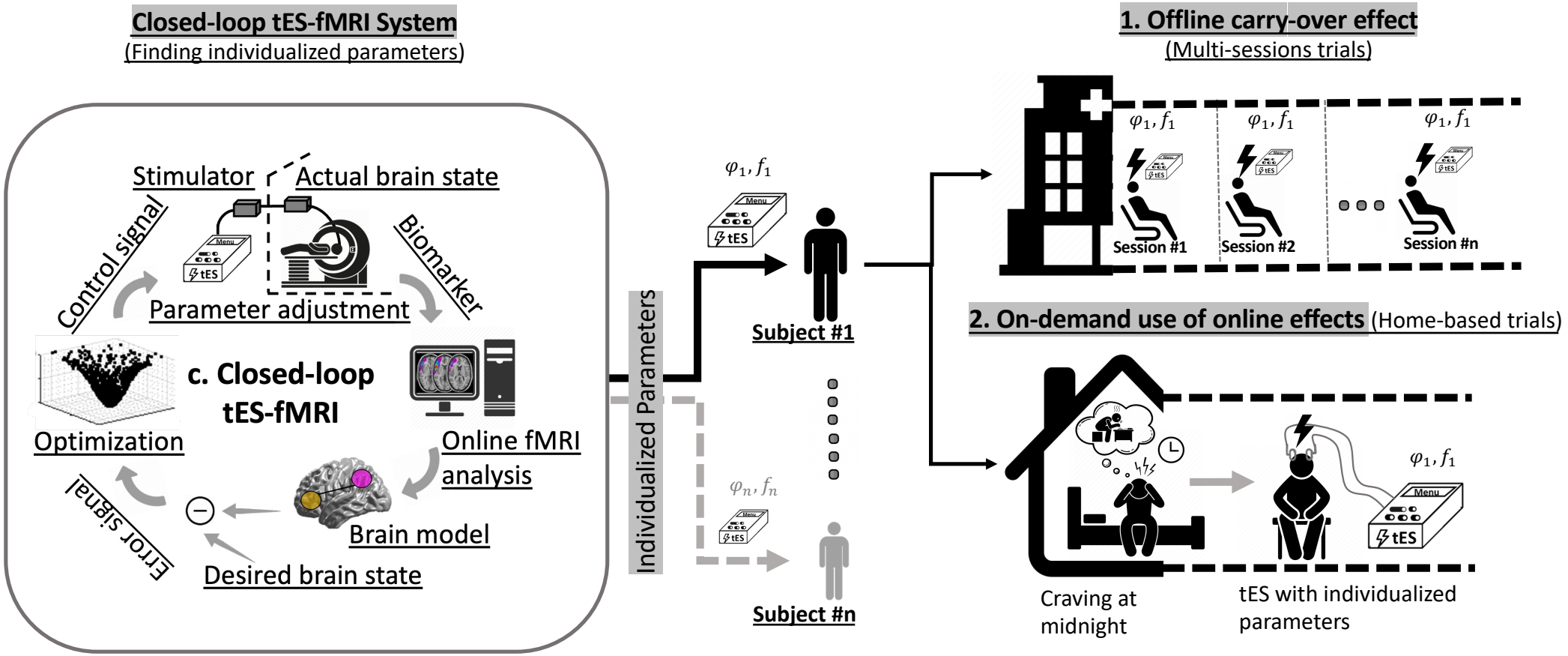
doi: https://doi.org/10.1101/2021.04.10.439268

SCAN ME

Closed-loop tES-fMRI System
(Finding individualized parameters)




Closed-loop tES-fMRI System
(Finding individualized parameters)
Stimulator
Actual brain state
Control signal
Biomarker
Parameter adjustment
c. Closed-loop
tES-fMRI
Optimization
Online fMRI
analysis
Error signal
Brain model
Desired brain state
Individualized Parameters
φ_1, f_1
Subject #1
φ_n, f_n
Subject #n
1. Offline carry-over effect
(Multi-sessions trials)
φ_1, f_1
Session #1
φ_1, f_1
Session #2
φ_1, f_1
Session #n


Closed-loop tES-fMRI System
(Finding individualized parameters)
Stimulator
Actual brain state
Control signal
Biomarker
Parameter adjustment
c. Closed-loop tES-fMRI
Optimization
Online fMRI analysis
Error signal
Brain model
Desired brain state
Individualized Parameters
φ_1, f_1
Subject #1
φ_n, f_n
Subject #n
1. Offline carry-over effect
(Multi-sessions trials)
Session #1
Session #2
Session #n
2. On-demand use of online effects (Home-based trials)
Craving at midnight
tES with individualized parameters
Menu
tES

ISAM-NIG, INTAM, INTF, and VICONS joint webinar:

Personalized Non-Invasive Brain Stimulation for Addiction Treatment

July 27, 2022, 10:00 AM – 12:00 PM (ET)

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USA

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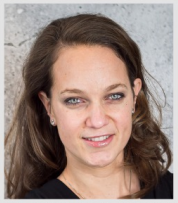
USA



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Jonathan Young
Duke University, USA

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NIDA, USA

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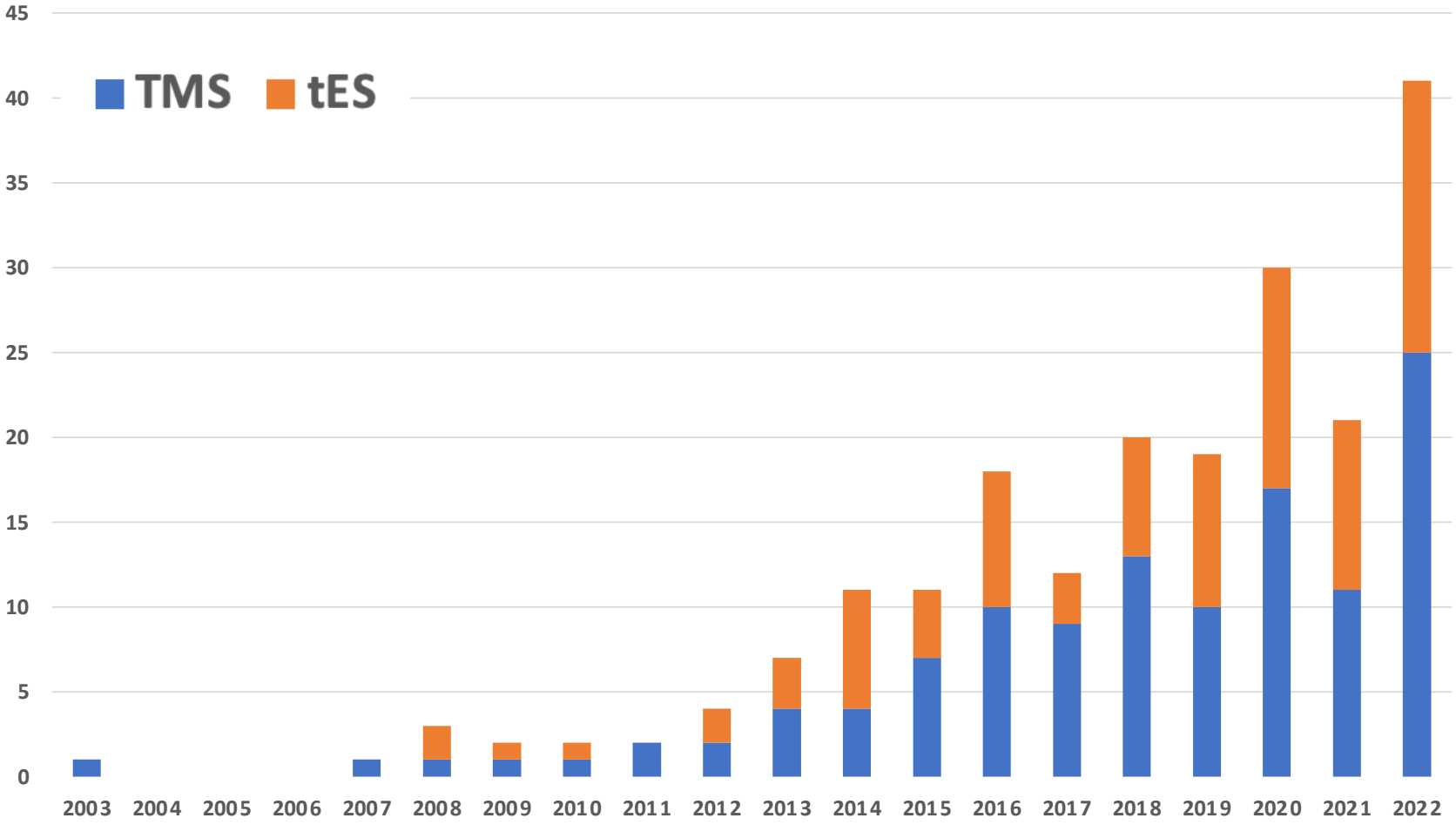
Published Trials with tES (86) or TMS (119) in Drug Addiction

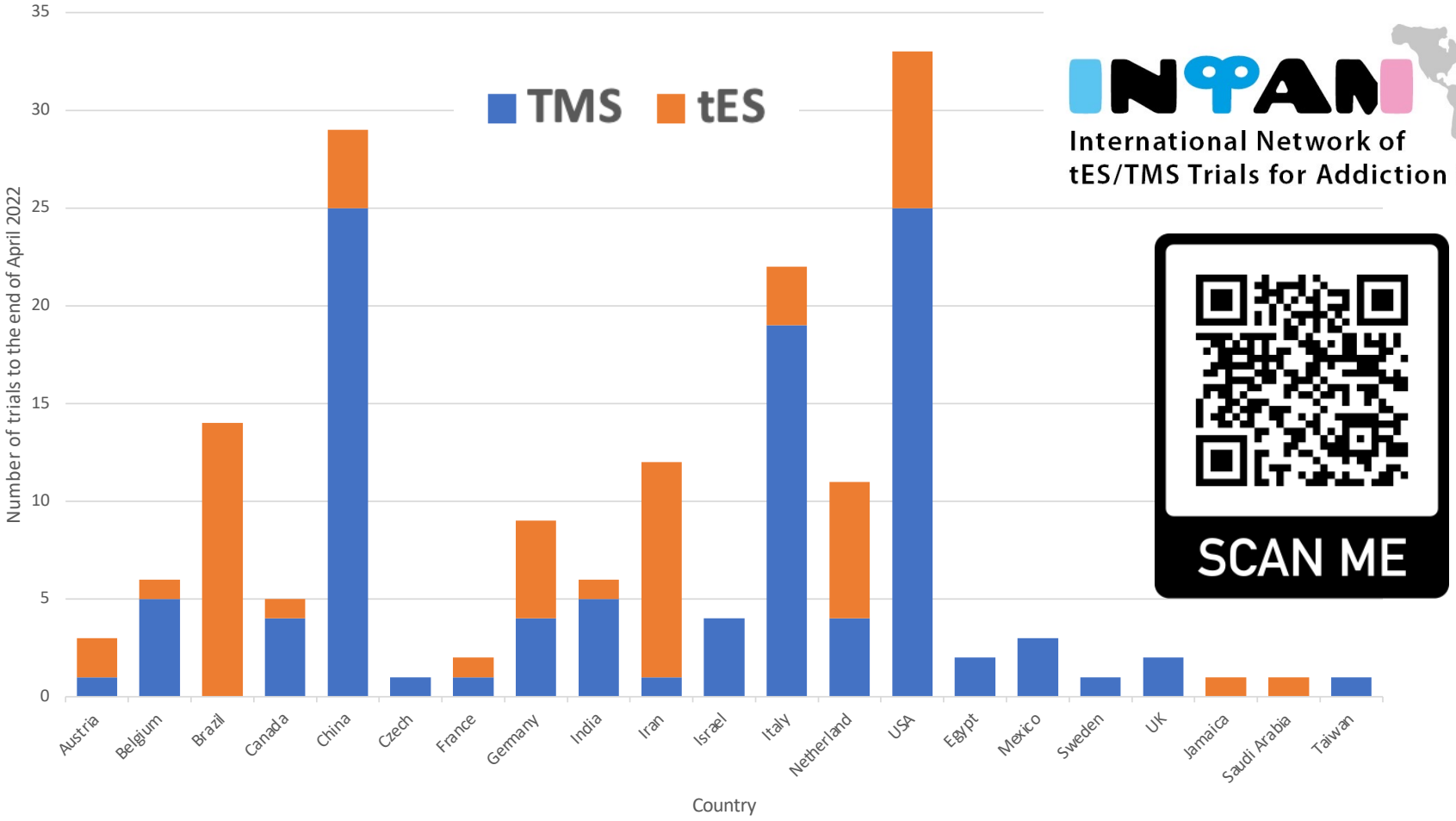


Afra Souki

Hosna Tavakoli

Ghazaleh Soleimani

How Different Countries Are Being Involved?



INPAM
International Network of
tES/TMS Trials for Addiction Medicine

SCAN ME

Neuroscience and Biobehavioral Reviews 104 (2019) 118–140

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

Review article

Transcranial electrical and magnetic stimulation (tES and TMS) for addiction medicine: A consensus paper on the present state of the science and the road ahead

Hamed Ekhtiari[a,*], Hosna Tavakoli[b,c], Giovanni Addolorato[d,e], Chris Baeken[f], Antonello Bonci[g,h,i], Salvatore Campanella[j], Luis Castelo-Branco[k], Gaëlle Challet-Bouju[l], Vincent P. Clark[m,n], Eric Claus[n], Pinhas N. Dannon[o], Alessandra Del Felice[p,q], Tess den Uyl[r], Marco Diana[s], Massimo di Giannantonio[t], John R. Fedota[u], Paul Fitzgerald[v], Luigi Gallimberti[w], Marie Grall-Bronnec[l], Sarah C. Herremans[f], Martin J. Herrmann[x], Asif Jamil[y], Eman Khedr[z], Christos Kouimtsidis[A], Karolina Kozak[B,C], Evgeny Krupitsky[D,E], Claus Lamm[F], William V. Lechner[G], Graziella Madeo[g], Nastaran Malmir[c], Giovanni Martinotti[t], William M. McDonald[H], Chiara Montemitro[g,t], Ester M. Nakamura-Palacios[I], Mohammad Nasehi[J], Xavier Noël[j], Masoud Nosratabadi[K], Martin Paulus[a], Mauro Pettorruso[t], Basant Pradhan[L], Samir K. Praharaj[M], Haley Rafferty[k], Gregory Sahlem[N], Betty jo Salmeron[g], Anne Sauvaget[O,P], Renée S. Schluter[a,b], Carmen Sergiou[Q], Alireza Shahbabaie[y], Christine Sheffer[R], Primavera A. Spagnolo[S], Vaughn R. Steele[u], Ti-fei Yuan[T], Josanne D.M. van Dongen[Q], Vincent Van Waes[U], Ganesan Venkatasubramanian[V], Antonio Verdejo-García[W], Ilse Verveer[Q], Justine W. Welsh[H], Michael J. Wesley[X], Katie Witkiewitz[n], Fateme Yavari[y], Mohammad-Reza Zarrindast[Y], Laurie Zawertailo[B,C], Xiaochu Zhang[Z], Yoon-Hee Cha[a], Tony P. George[B,C], Flavio Frohlich[aa], Anna E. Goudriaan[ab,ac], Shirley Fecteau[ad], Stacey B. Daughters[aa], Elliot A. Stein[u], Felipe Fregni[k], Michael A. Nitsche[y,ae], Abraham Zangen[af], Marom Bikson[ag], Colleen A. Hanlon[N]

Ekhtiari and Paulus:

Neuroscience for Addiction Medicine: From Prevention to Rehabilitation

(First Edition)

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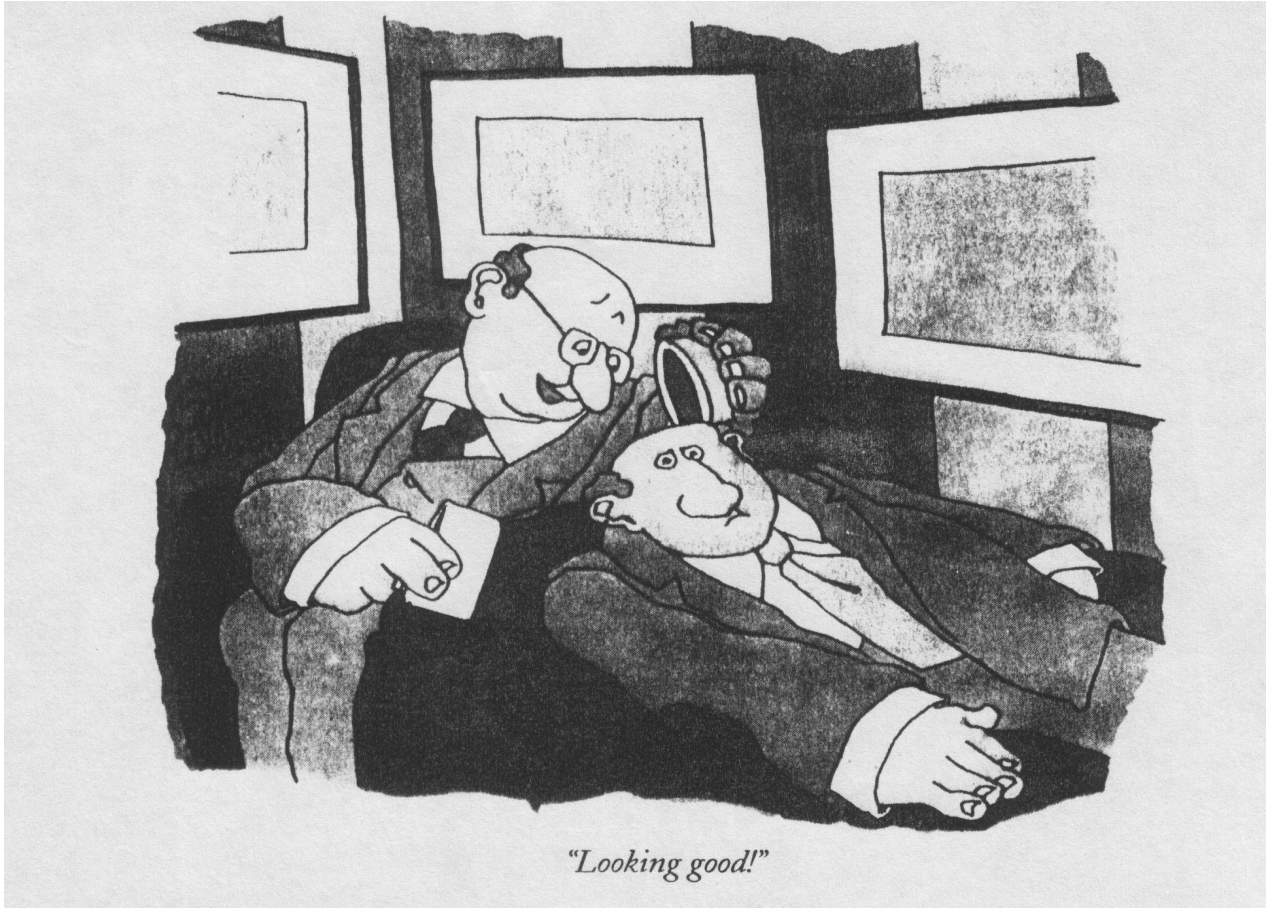
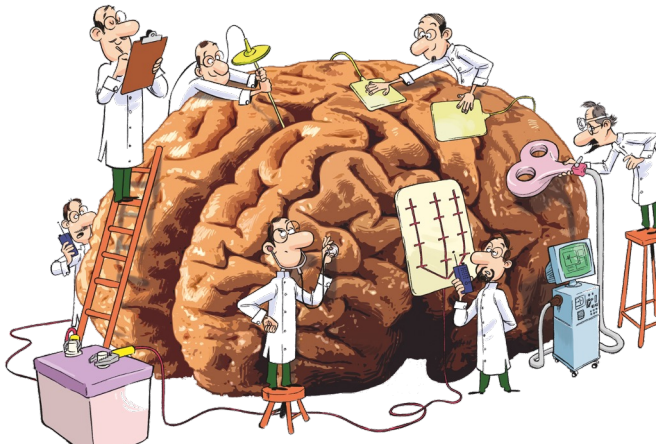
Future of Psychiatry with MRI and Brain Stim?

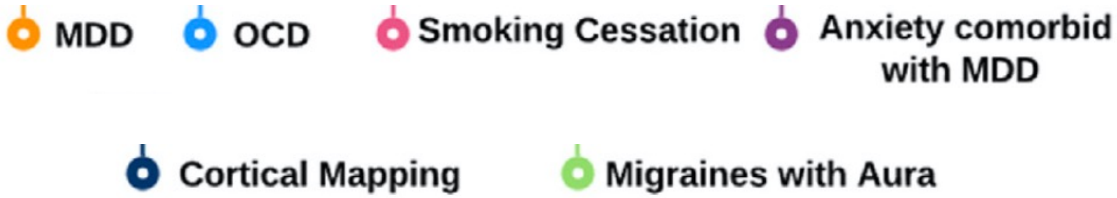


Take Home Notes

- What is tES and TMS!



How Many FDA Approvals We Have for Non-Invasive Brain Stimulation in Psychiatry?



A visual and narrative timeline of US FDA milestones for Transcranial Magnetic Stimulation (TMS) devices

How Many FDA Approvals We Have for Brain Stimulation in Psychiatry?

MDD

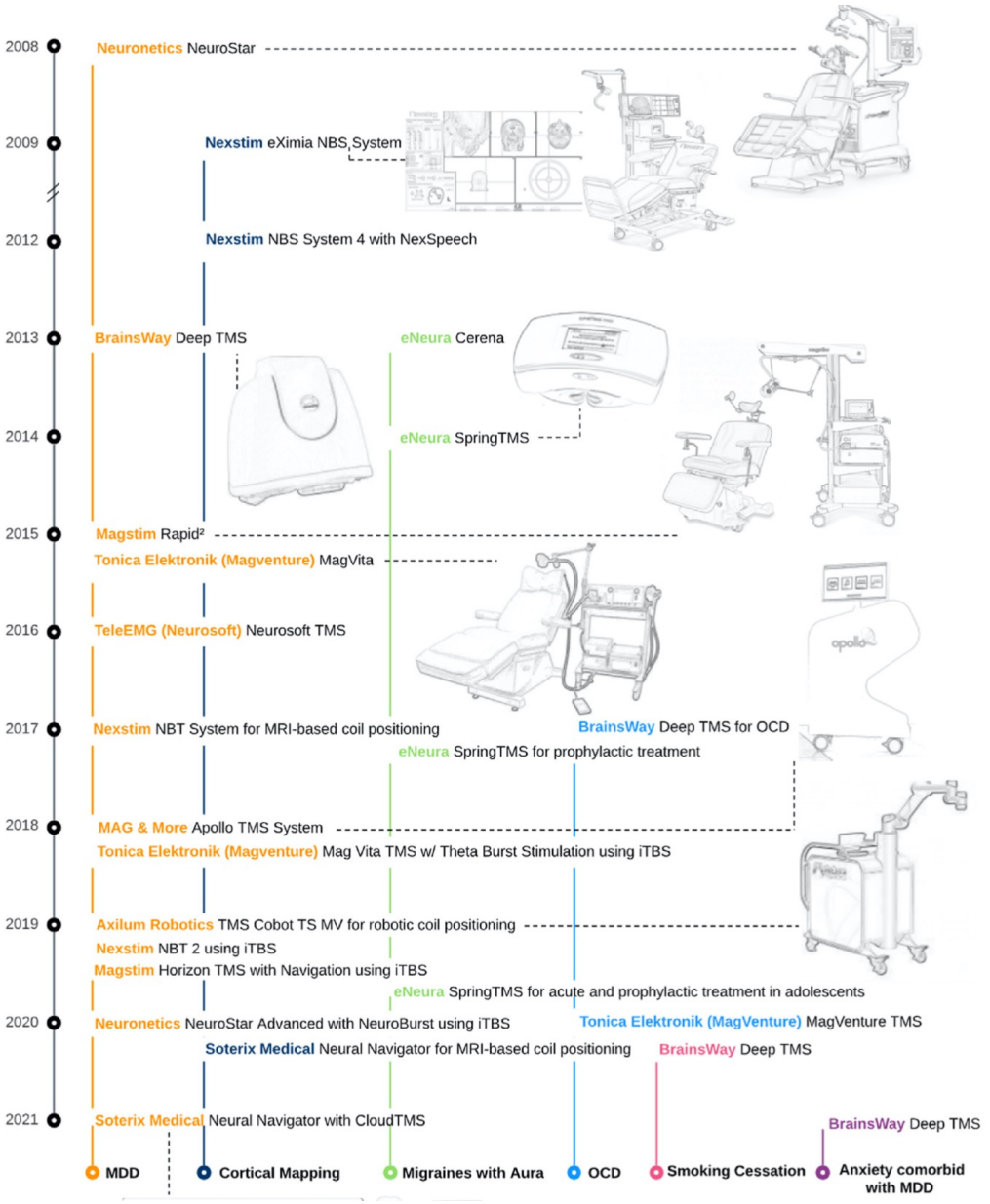
Cortical Mapping

Migraines with Aura

OCD

Smoking Cessation

Anxiety comorbid with MDD

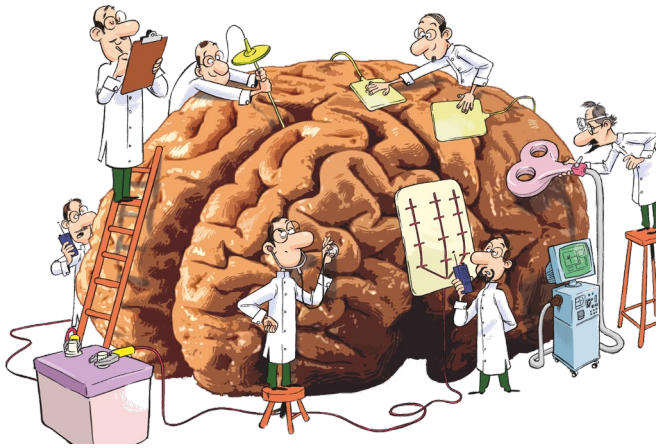


S.L. Cohen, M. Bikson, B.W. Badran et al.

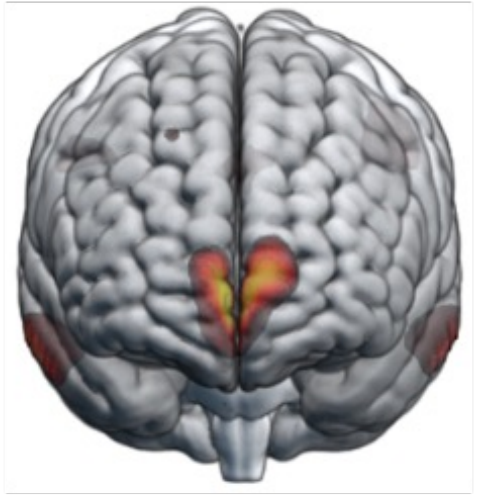
Brain Stimulation 15 (2022) 73–75

Take Home Notes

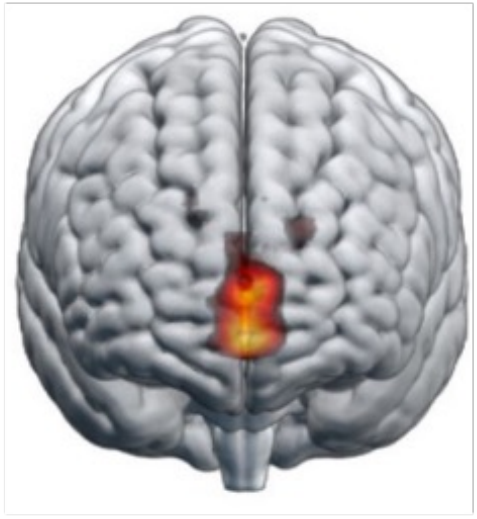
- What is tES and TMS!
- Cue Induced Craving
- Growing Body of tES/TMS Studies in Addiction
- Brain Stimulation Targets for Addiction



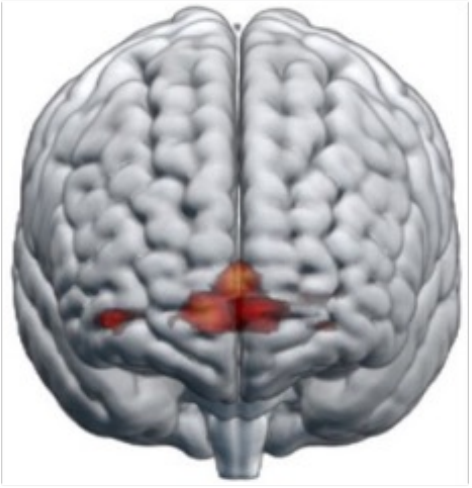
a. Lesion-based, Alcohol & Smoking



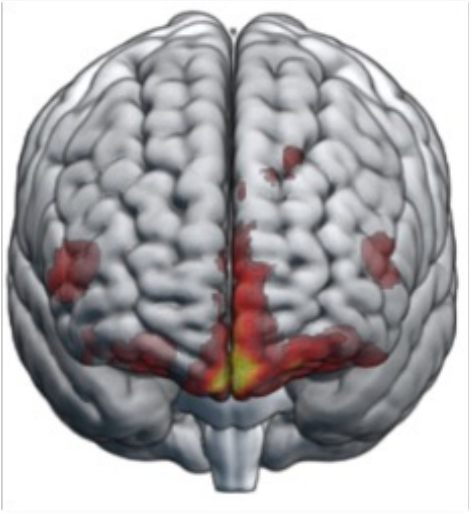
b. Cue-reactivity, Alcohol

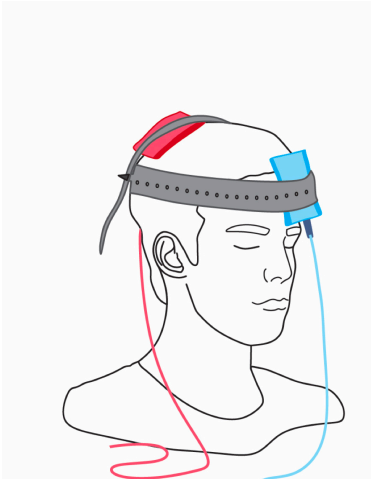


c. Cue-reactivity, Smoking

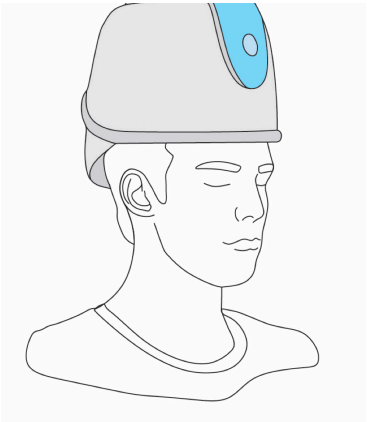


d. Cue-reactivity, Methamphetamine

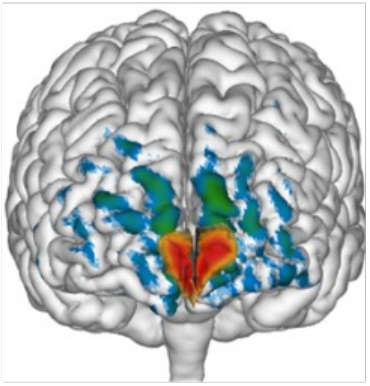




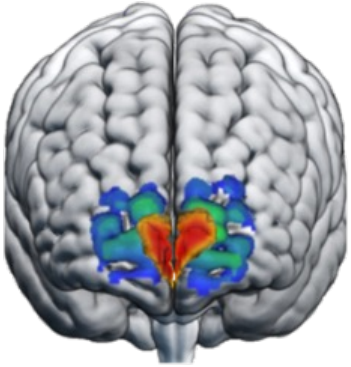
c. tES electric field maps



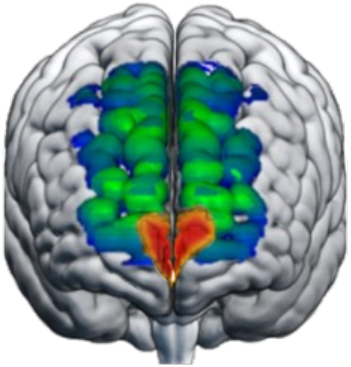
d. TMS electric field maps



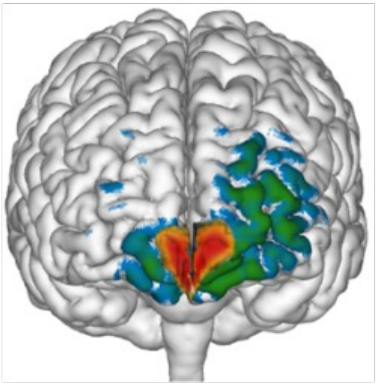
c1. DLPFC montage



d1. H4 coil



d2. H7 coil



d3. Figure8 coil

Review

Converging Evidence for Frontopolar Cortex as a Target for Neuromodulation in Addiction Treatment

Ghazaleh Soleimani[1], Ph.D., Juho Joutsa[2,3], M.D., Ph.D., Khaled Moussawi[4], Shan H. Siddiqi[5], M.D., Rayus Kuplicki[6], Ph.D., Marom Bikson[7], Ph.D., Martin P. Paulus[6], M.D., Ph.D., Michael D. Fox[5], M.D., Ph.D., Colleen A. Hanlon[8], Ph.D., Hamed Ekhtiari[1,6#], M.D., Ph.D.

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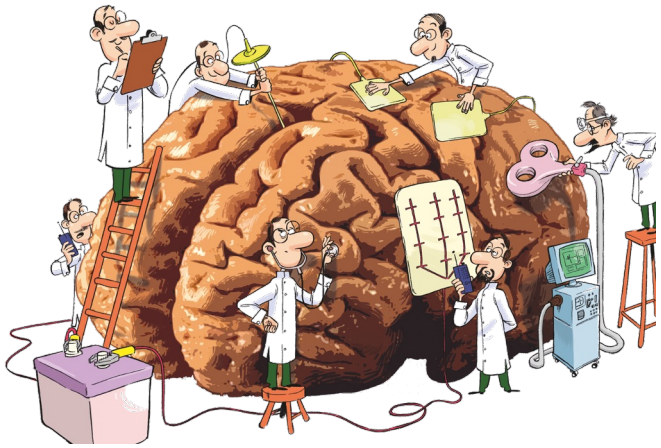
Second Revision in

The American Journal of Psychiatry

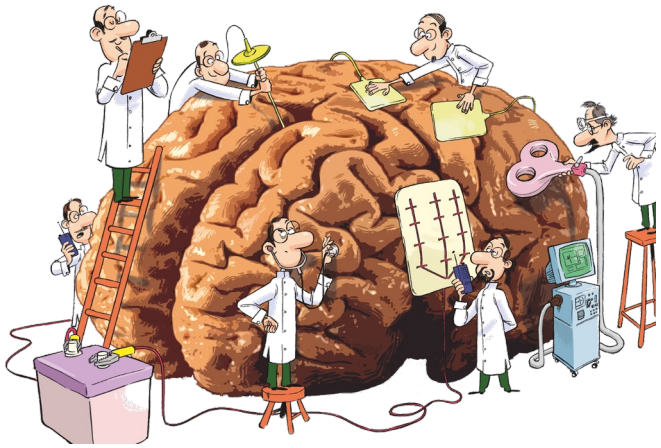
Take Home Notes

- What is NIBS!
- Cue Induced Craving
- Growing Body of NIBS in Addiction
- NIBS Targets for Addiction
- Large Interindividual Variability



Take Home Notes

- What is NIBS!
- Cue Induced Craving
- Growing Body of NIBS in Addiction
- NIBS Targets for Addiction
- Large Interindividual Variability
- sMRI and fMRI to Inform the Stimulation Parameter
- Potentials for Individualized Interventions
- Future of Interventional/Precision Psychiatry
- Neuroscience-informed Patient Education



10 Brain Functions Injured by Alcohol & Other Drugs

1 Attention

I often experience that environmental triggers can produce an inability in me to control my desire to use my drug of preference, even when I do not want to use because using is all I can think about. When this happens, I have very little ability to shift my focus to anything else. Even carrying-on a conversation with someone is very difficult when I am locked-on to thinking about using. Multi-tasking of any kind is nearly impossible when I am pulled into thinking about drug use when driven by environmental cues.

2 Memory

I believe my memory has been negatively affected by my drug use. I seem to experience "involuntary" memories related to my using such as when I pass by or think about places where I would use. I am experiencing lapses in short-term memory, forgetting things as recent as what I have for lunch or if I returned a phone call. I feel like this may cause others to loose trust in me.

3 Decisions & Control

I can make a decision to refrain from using but many times, I am unable to follow-through with my decision. I feel powerless over my ability to not use, even when I don't want to, especially if I have recently used. Once I am in the presence of and actually see my drug of preference, I lose control. I cannot successfully choose to not use, as if a powerful force takes over and I am at the mercy of craving my drug, using despite my resolve not to. When I am craving, I feel emotionally unstable, my mood changes quickly from happy-to-sad, angry-to-rage, without much stimulus to incite the change. It just happens, without my permission.

4 Movement & Speech

I often find myself searching for the right words in conversations, words I used to know in the context for which I seek them. I feel very limited in my vocabulary resources; very unlike I used to feel in conversation which was confident and adept. I find myself stuttering and/or gropping for words.

I also feel like my coordination and dexterity have diminished a great deal. Movements and tasks that used to come very easily for me are much more difficult and I feel sluggish. My driving skills and confidence behind the wheel have diminished and this makes me very fearful of being at high-risk to have an accident.

5 Brain-Body Connection

I do not feel like I am in touch with my bodily senses anymore. When I am stressed, craving, depressed or anxious I do not feel like my mind and body communicate; therefore, I am not aware what my body may need at certain times, such as when I need to hydrate, when I am hungry, or fatigued. It's like my mind and body are completely out of touch with each other. My emotions often present themselves through bodily sensations, so when I don't pay attention to my "gut level senses", the result is an inability to control these emotions.

6 Arousal and Sleep

I have a difficult time falling asleep and staying asleep. I wake-up startled and anxious, I can feel my heart beat too loudly, remain anxious, excitable and easily aroused. I find it very hard to become calm once I am experiencing these states. In contrast, sometimes I feel drowsy and sleepy when I believe I should be alert during work.

My body, mental state, and emotional being feel heavy and I often find physical movement and motivation to move very challenging.

7 Feeling Bad

I often experience negative feelings like a dramatic sense of guilt, becoming stuck in the self-debasement, and a profound fear of abandonment. Experiencing these feelings around my drug use creates a great deal of anxiety, even confuses and angers me. Certain words and sounds can be distressing, causing me to feel intensified anxiety and stress. These negative feelings result in an intense DRUG CRAVING in me. Despite evidence from experience to the contrary, I can still find myself believing that using drugs is the only solution to help me relax and feel better.

8 Feeling Good

The seduction of drugs for me is highly rewarding and beckons me, loudly and frequently. The rewarding experience begins with simply thinking about my drug or obtaining it. It induces a kind of pleasure for me that even thinking about them not just seeing, causes this change. The degree of promised reward from my drug profoundly replaces other formerly pleasurable things. I seem to avoid doing things and going places that I used to enjoy. Without using drugs to change the way I feel, I do not seem to have effective skills to entertain myself or possess a basic interest in doing previously enjoyable activities alone.

9 Social Cognition

I have difficulty identifying and expressing my emotions, clearly and understandably. I realize that I cannot accurately pick-up on cues coming from other people about how they see me or interpret my behavior, so I have lost my ability to empathize. Because I cannot access this type of insight, communicating with my family and others is especially difficult for me. I also seem to be unable to end uninterested in making new friends.

10 Awareness & Insight

Despite what some of my friends, relatives, and co-workers might say, I do not see myself as someone who has a disease, needs medical care or other treatment. I only drink and use recreationally and can stop anytime I want to. I simply don't want to. I am tempted to use because it feels good when I use. I like the effects produced by alcohol and/or other drugs, cannot see, in the using brain state, how they hurt me; therefore, I do not see the benefit of abstaining or asking for help.

In Summary

A healthy brain is an absolute necessity for a happy, meaningful, and purposeful life. Chronic use of intoxicants such as: alcohol, cocaine, heroin, meth, OxyContin, marijuana and many others, regardless of whether they are legal or illegal can lead to serious brain impairment, even damage, dysfunction and greatly diminished brain functions. Fortunately, research shows that the human brain is capable of being restored or even improved in function in Recovery with the right approaches and exercises during abstinence. In upcoming posters, we will offer some ideas about how to improve your brain healing and recovery, to support abstinence from intoxicants. To learn more, please consult our companion book: "Brain-Healing First Aid: How to Recover My Brain's Abilities during Addiction Treatment"

Authors: Hamed Ekhtiari, Tara Rezapour, Brad Collins, Martin Paulus; Illustrator: Naeem Tadayon; Graphists: Mohsen Farhadi, Ryan Haight

Addiction Treatment and Recovery Center
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Scan the QR code above with your smartphone to get a free PDF version of the book.

10 "Do's" to Foster Brain Recovery Starting at Initial Abstinence

1 Commit to abstinence from intoxicants

1. **Avoid** places where you used/drank. Any drug related cue can activate processes in your brain that are harmful for its health.
2. **Break** relationships with all using partners. Your brain needs new healthy friends to be able to recover.
3. **Affirm** commitment to "total abstinence" from any drug, including alcohol, legal or illegal. Your brain is very vulnerable to any intoxicant during recovery. Take care of it responsibly.

2 Be patient and hopeful

1. **Treat** your brain as you would any other injured part of your body that needs extended rest and healing for a period of time to experience recovery
2. **Rely** upon the example of other injuries healing over time, accept that you will achieve your brain health gradually
3. **Gather** with and call upon people in successful recovery to benefit from their experience, strength, and hope

3 Be calm and relaxed

1. **Not unlike** other bodily injuries, your brain needs sufficient time to become peaceful and calm to experience healing
2. **Stress** is your brain's worst enemy and exposure to heightened stress hampers the recovery process
3. **Avoid** when possible, people, places, events and other things that tend to raise your stress level. You can start to gradually and slowly expose yourself to normal life stressors after first few months of recovery under supervision of your counselors and therapists.

4 Be a healthy sleeper

1. **Your brain** needs sufficient (but not too much) sleep at night and periods of daytime rest to recharge
2. **Turn** your bedroom in to a sleep haven; calm and dark with proper temperature. This will help your brain to take advantage of sleep as much as possible for its recovery.
3. **Commit** to and maintain a regular, healthy and helpful sleep schedule. Fixed daily schedule for sleep will help your brain to be rested and accessible when you need it.

5 Be a healthy foodie

1. **Include** more fruit especially berries and dark green leafy vegetables in your diet. Their natural antioxidants and vitamins will help your brain to recover injured and inflamed areas.
2. **Eats lots** of oily fish (salmon and tuna) and eggs. Their micronutrients will provide your brain with materials to restore its disturbed structures.
3. **Reduce** salt intake and make intentional efforts to lower Cholesterol

6 Be in tune with your emotions

1. **Learn and practice** problem-solving strategies in order to deal with daily life problems
2. **Gain** skills to practice emotional awareness in order to identify and separate various emotional states and feelings
3. **Attend** to leisure and recreation activities that can soothe and restore your brain

7 Be more socially active

1. **Get involved** with other people who are living in recovery successfully
2. **Be committed** to engage in 12 step or other mutual support groups regularly
3. **Be willing** to focus your relationships with people, including family members, who encourage and support your abstinence and recovery

8 Be more physically active

1. **Try** to make time for regular exercise and other physical activities. Your brain and body generate chemicals during rigorous physical activity, including workouts that promote your brain recovery
2. **Engage** in aerobic exercises, as recommended for someone of your age, medical condition, build, and gender to promote holistic health but, avoid too much or too intensive exercise
3. **Try** exercising in group-settings for support, encouragement and meet the social needs of your healing brain

9 Be a healthy friend to yourself

1. **Be mindful** of your emotions, thoughts and behaviors as often and intentionally as possible
2. **Be willing** to practice yoga or attend any type of meditation classes. Practice meditation exercise as part of a daily program to help your brain progress in recovery
3. **Be willing** to practice mindfulness exercises in daily tasks, such as eating, walking, and cleaning house/yard work, etc. Experiencing normal pleasures from normally pleasurable tasks is a staple of recovery

10 Be more mentally active

1. **Honor** the fact that your brain needs exercise along with your body to be able to regain its fully-integrated functions
2. **Be willing** to do brain exercises which are systematically designed for improvement of brain functions (see our next poster)
3. **Progress gradually** into difficult and challenging levels of brain exercise, much like you might increase the weights in gym exercises. Follow the recommendations of a counselor, recovery coach or other helping professional in regard to the type and level of mental exercises you practice

In Summary

Your brain during early abstinence is like a broken hand. It needs your active support to be able to recover properly. After the initial weeks of abstinence, your brain will need active rehabilitation exercise to start to recover its own abilities over the time. The brain healing takes time but it is guaranteed if you pay enough time and attention to it. You can have more details about the brain exercises in our next poster or in our book "Brain-Healing First Aid: How to Recover My Brain's Abilities during Addiction Treatment"

Authors: Hamed Ekhtiari, Tara Rezapour, Brad Collins, Martin Paulus; Illustrator: Naeem Tadayon; Graphists: Mohsen Farhadi, Ryan Haight

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Scan the QR code above with your smartphone to get a free PDF version of the book.

10 Series of Daily Brain Exercises for Brain Recovery During Abstinence

1 Attention

1. **Do Word Exercises:** Practice reverse spelling during daily conversation and spell the words you hear backward in your mind. Ex: Apple could be elppa in your "Brain language"
2. **Be Your "Present-Moment" Attention Coach:** You can practice controlling your attention and lessen your brain's tendency to wander during important tasks. Intentional, gentle and internal messages such as "focus on the task at hand" or "come back to the present moment" can become a habit to bring you back into focus.
3. **Train Your Brain to be Flexible:** Try to shift between two or more brain tasks as a daily exercise. Ex: Practice a Sudoku puzzle for 10 min and then shift to solving a crossword for 10 min and then return to the Sudoku again.

2 Memory

1. **Journal in Your Brain Book:** Document important events that influenced your day every night. You can visualize and observe the events of your day as if watching a play.
2. **Play "Memory Games":** Prepare a list of information such as a grocery list or word list every day and try to memorize it throughout the day. Commit a snapshot of the list to memory for ready-access, so new words will be available when you need them.
3. **Reduce "Brain Clutter":** Try to reduce the load of information taking up brain-space by economizing strands into smaller, associated "chunks". Ex: Instead of remembering 140593251, simplify to 140-593-251. Any other innovative ways to organize and chunk information will help your memory.

3 Decisions & Control

1. **Set Daily Goals:** Set at least one goal every day and strive to achieve it by the end of that day. Small goals such as saving $20 when shopping or walking 1/2 a mile, to start are worthwhile. You can gradually set 7 goals for each week and achieve them.
2. **Track Your Money:** Try to monitor your daily money spending, even when it is very low, with writing and calculating on paper. Being a good personal money manager will help you to take more control in other aspects of your life.
3. **Practice Patience:** Whenever you feel overwhelmed by impulses and emotions to make a decision or take an action, stop, take a deep breath, and close your eyes. Then starting from 10, count up to 20 slowly.

4 Movement & Speech

1. **Observe Your Brain Processes:** You can monitor what is happening inside your brain and ask yourself such questions as: "What type of process is my brain engaged in right now?" "What brain processes encourage me to feel certain emotions such as glad, sad, or mad?"
2. **Attend to Your Posture:** Use your brain power to monitor your posture moment by moment especially when you are in the middle of walking, typing or watching TV.
3. **Live Weight-Conscious:** If your body weight has been a health risk for you, find out what your ideal BMI is. Find brain processes that help you reach your food intake and body weight goals.

5 Brain-Body Connection

1. **Practice Body-Presence:** Focus on your body while you are exercising, practicing yoga, sitting in meditation, etc. Instead of listening to the music. Experience the communication created between your brain and body and feelings associated with it.
2. **Observe Your Heart Rate:** Check your pulse several times during different activities throughout the day. Tune-in to the message your pulse and heart rate will offer at various conditions. Try different ways to check your pulse. Even try to feel your heart beat without touching your external body? Can you sense it?
3. **Practice Mindfulness:** Observe your environment and your body with curiosity and pay attention to sounds around you as if it is your first time to experience them.

6 Arousal and Sleep

1. **Create a Sleep Haven:** Prepare your bedroom for a relaxing and soothing sleep by making it dark and quiet. Turn your electronic devices to silent and offer yourself comforting supports, such as an ideal pillow.
2. **Pamper Yourself Occasionally:** Utilize spa activities such as massage, sauna, hot tub, manicure, pedicure, etc. whenever possible. You can even use your home bathtub as your personal spa.
3. **Enjoy the Benefits of Warmth/Heat:** Take a warm shower to ease tension in your muscles. Set your home water on a therapeutic temperature to relax your joints and muscles.

7 Feeling Bad

1. **Use Positive Language:** Replace negative words with positive ones. Use positive affirmations such as: "Look how far I have come" as opposed to: "I am not progressing fast enough".
2. **Live in Gratitude:** Consistently acknowledge things for which you are grateful. To your recovery, friends, to your family, to yourself and to your spiritual life. Make a list of areas and things in your life for which you are grateful.
3. **Volunteer for Charity Work and Express Your Spiritual Generosity:** Help other people even if it seems small. Volunteering or charity work is a great opportunity to be of service to others.

8 Feeling Good

1. **Be a Member of the Happiness Club:** Try to laugh and share

9 Social Cognition

1. **Practice Paraphrasing:** Select a paragraph from recovery literature, a magazine or a newspaper and read it mindfully. Then rewrite the paragraph in your own words, using synonyms and alternative descriptions.
2. **Enjoy the "Artist in You":** Grab a coloring book and allow yourself to get colorfully creative! Try to color without going outside the confines of the patterns.
3. **Improve Dexterity:** Don Henley, famed drummer for the Eagles, said he first began drumming by tapping on his school books and desk. Sit and intentionally strike drum beats, varied and different paced to improve and stimulate manual dexterity. Enjoy little competitions with yourself around speed, patterns and precision.

In Summary

Much like your body, your brain needs exercise on a regular and progre… sharp and encourage resiliency to handle the day-to-day rigors of life. … care. In this third educational poster, we introduce some of the exercise… any special equipment. So, please enjoy the offerings of our poster seri… tions for healing.

Authors: Hamed Ekhtiari, Tara Rezapour, Brad Collins, Martin Paulus; Illustrator: Naeem

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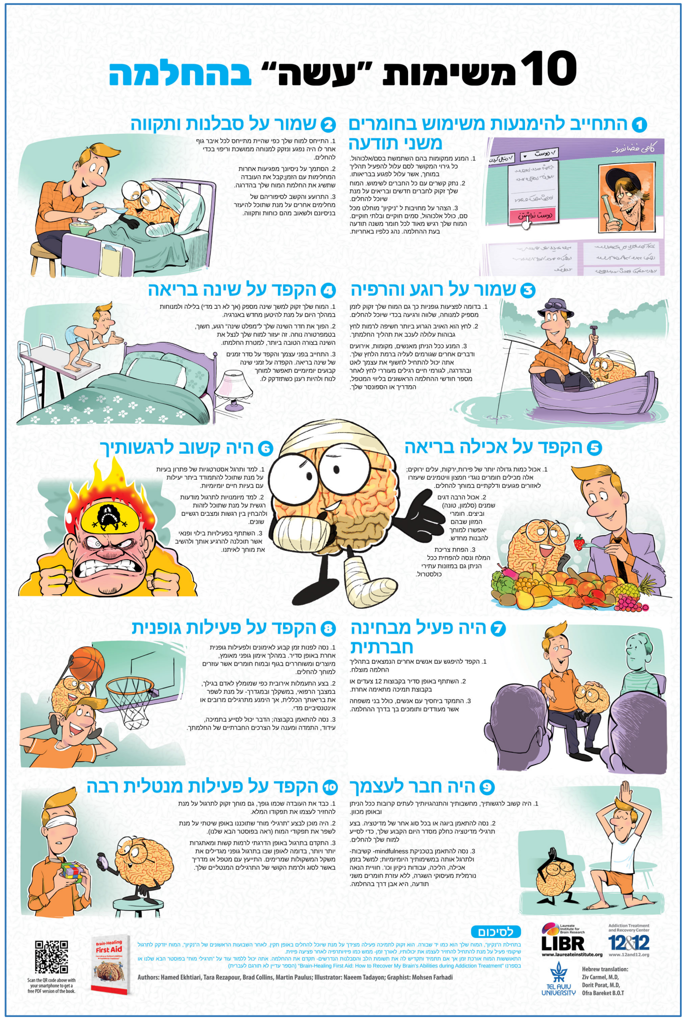
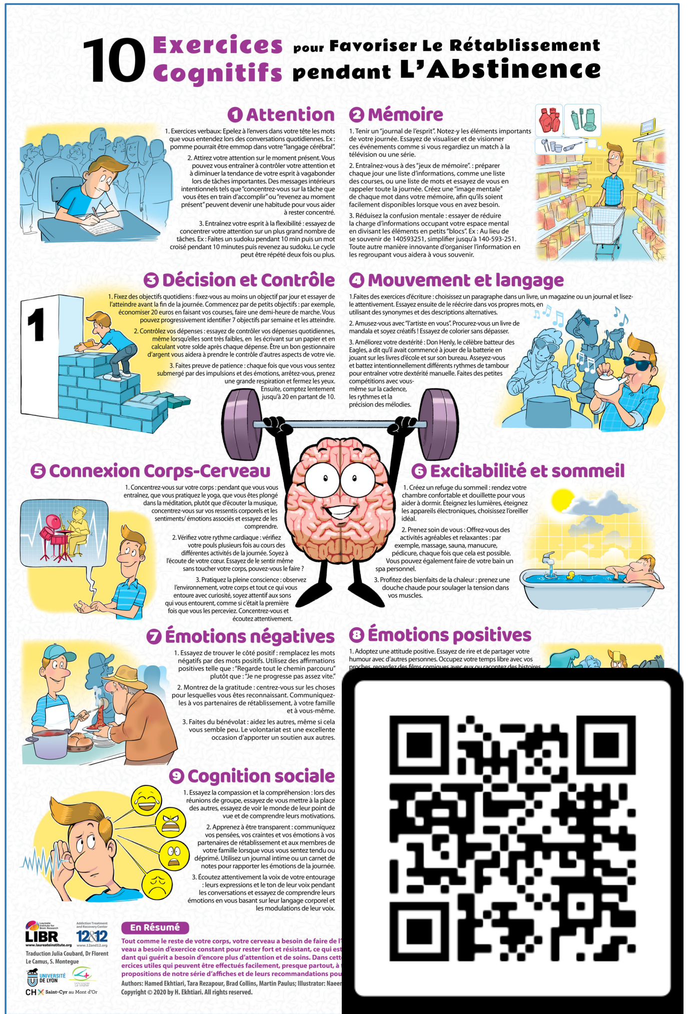
दिमाग और व्यसन (लत) सुधार का पहल (पोस्टर 1)
नशीले पदार्थ और शराब से बिगडनेवाले दिमाग के दस कार्य
1 ध्यान
2 स्मरणशक्ती / याददाश्त
3 निर्णय और क़ाबू
4 संचलन (मूव्हेंट) और संवाद
5 दिमाग और शरीर का संबंध
6 जागना और नींद
7 बुरा / खराब लगना
8 अच्छा लगना
9 सामाजिक संज्ञान
10 जानकारी (अवेर्नेस) और अंतर्दृष्टी
सारांश


10 משימות "עשה" בהחלמה
1 התחייב להימנעות משימוש בחומרים משני תודעה
2 שמור על סבלנות ותקווה
3 שמור על רוגע והרפיה
4 הקפד על שינה בריאה
5 הקפד על אכילה בריאה
6 היה קשוב לרגשותיך
7 היה פעיל מבחינה חברתית
8 הקפד על פעילות גופנית
9 היה חבר לעצמך
10 הקפד על פעילות מנטלית רבה
לסיכום


10 Exercices pour Favoriser Le Rétablissement Cognitifs pendant L'Abstinence
1 Attention
2 Mémoire
3 Décision et Contrôle
4 Mouvement et langage
5 Connexion Corps-Cerveau
6 Excitabilité et sommeil
7 Émotions négatives
8 Émotions positives
9 Cognition sociale
En Résumé

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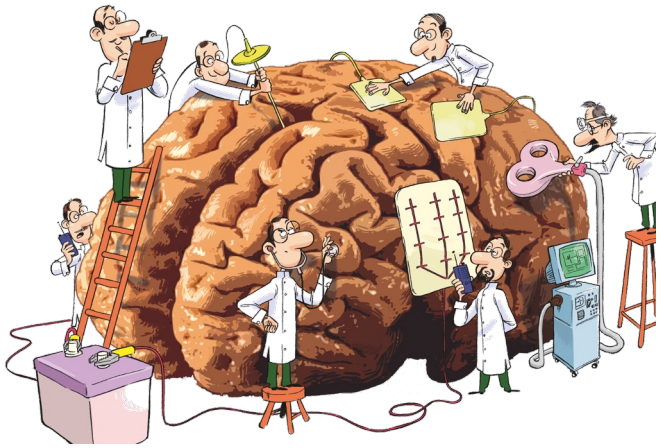
Persian	1	2	3	**Portuguese**	1	2	3	**Russian**	1	2	3	**Spanish**	1	2	3

Take Home Notes

- What is NIBS!
- Cue Induced Craving
- Growing Body of NIBS in Addiction
- NIBS Targets for Addiction
- Large Interindividual Variability
- sMRI and fMRI to Inform the Stimulation Parameter
- Potentials for International Collaboration
- Future of Interventional Psychiatry with MRI and NIBS
- Neuroscience-informed Patient Education
- Networking Activities INTAM and ISAM NIG



REVIEW ARTICLE Provisionally accepted The full-text will be published soon. Notify me

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A Roadmap for Integrating Neuroscience into Addiction Treatment: A Consensus of the Neuroscience Interest Group of the International Society of Addiction Medicine

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World Addiction Medicine Reports: Study Protocol for the International Society of Addiction Medicine (ISAM) Global Expert Network (ISAM-GEN) Surveys

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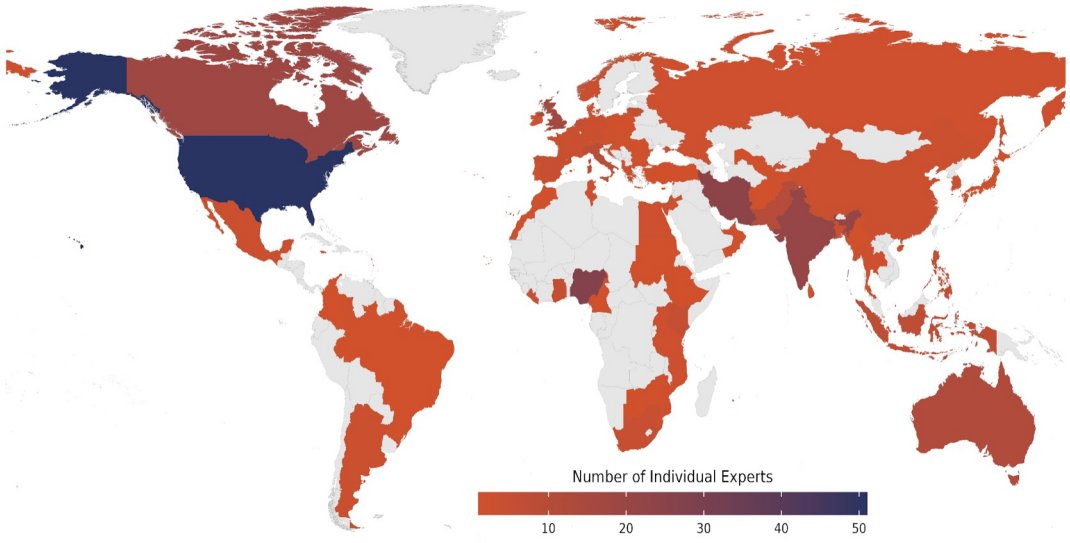
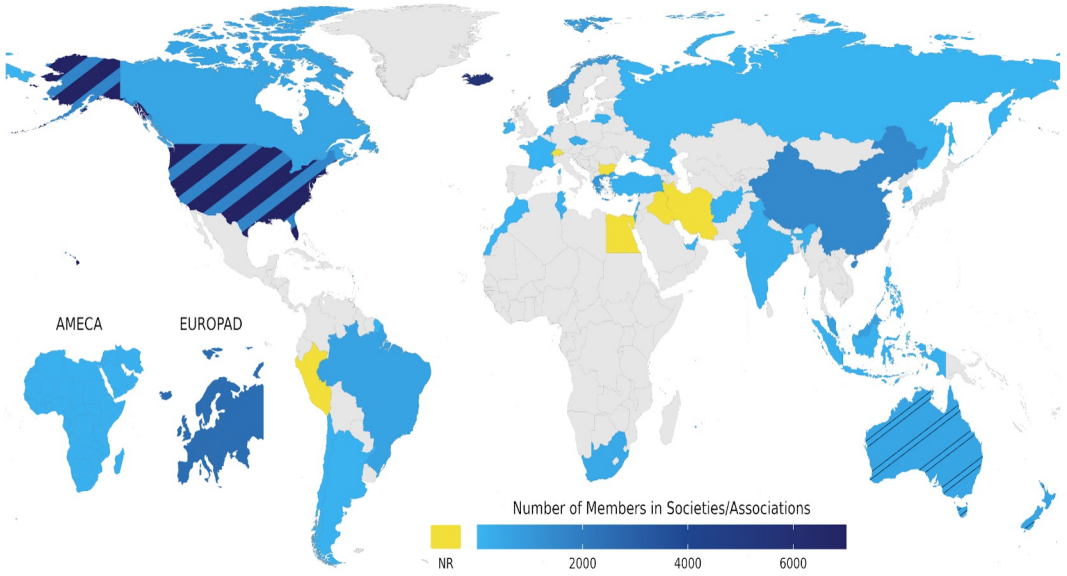
A. Global Distribution of Individual Addiction Experts



B. Global Distribution of Addiction Societies/Associations



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Improving Care and Compassion in Addiction:

XXV Years of Global Focus and Perspectives

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