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of New York

Motor learning with tDCS in Rats

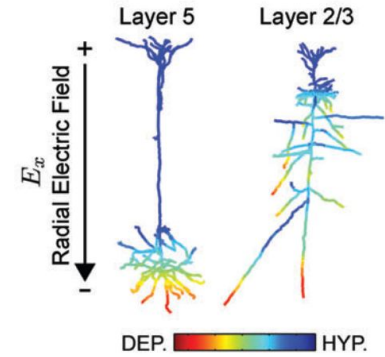
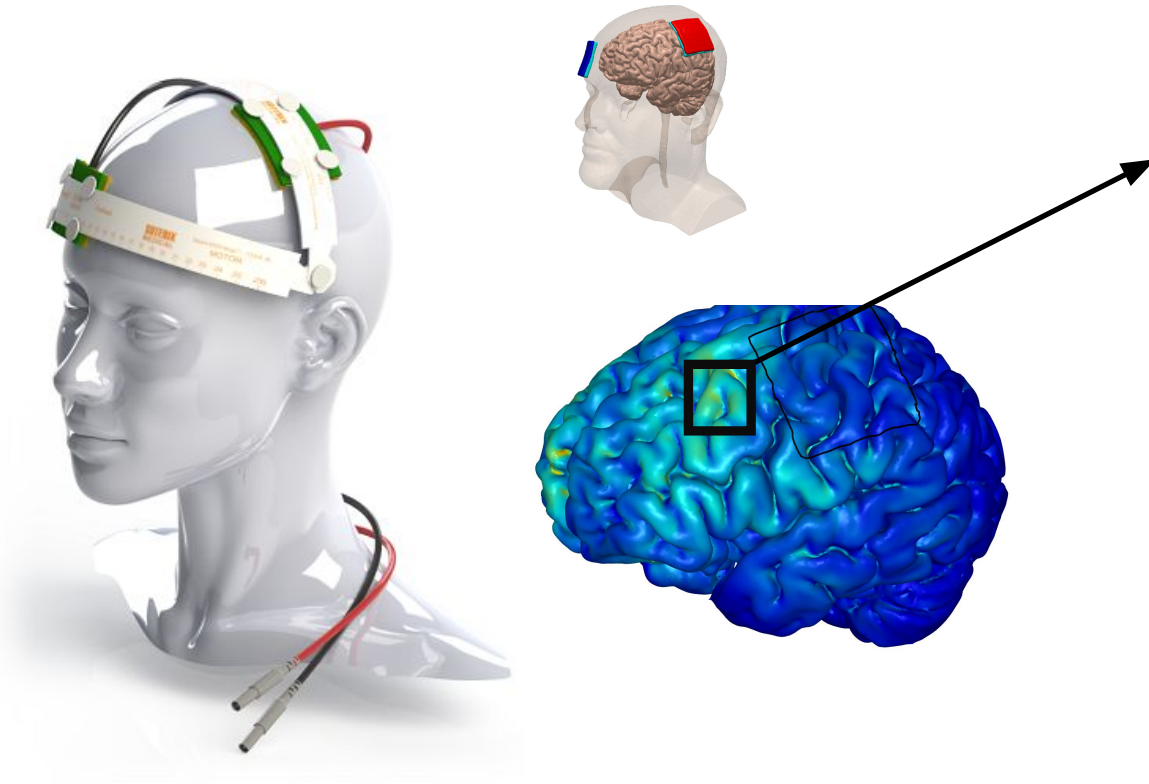
Forouzan Farahani

The City College of New York
Department of Biomedical Engineering



@ForouzanV

Transcranial Direct Current Stimulation (tDCS)



Rahman et al., 2013

Hypothesis:

DCS increases of somatic polarization in the postsynaptic neuron

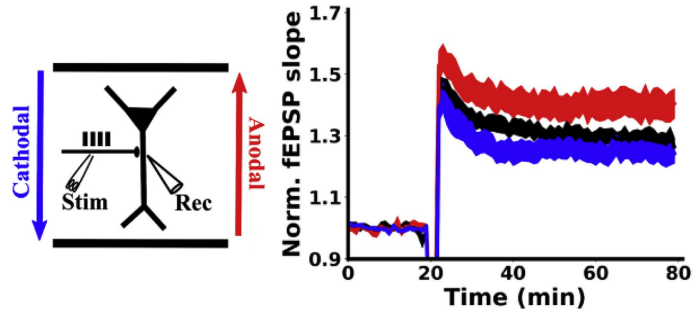


Increases the somatic spiking

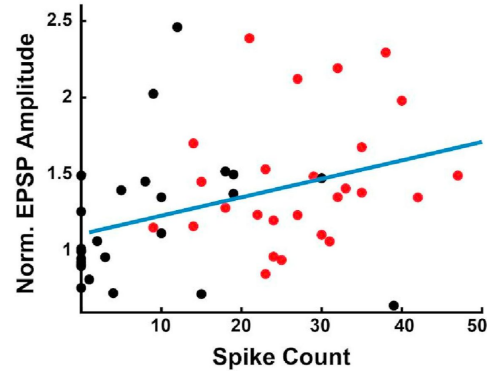


Boost LTP

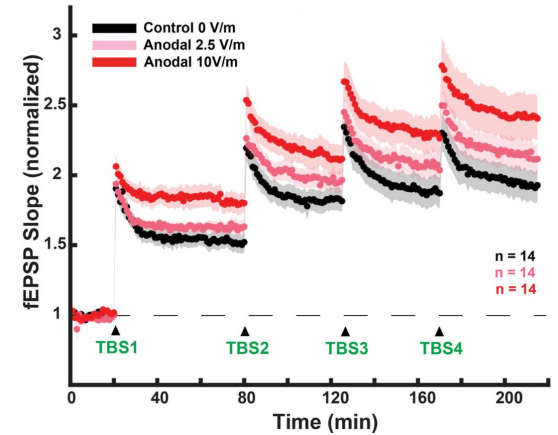
Do the effects of tDCS outlast the stimulation period?



Kronberg et al, Brain Stim 2020



Farahani et al, Brain Stim 2021

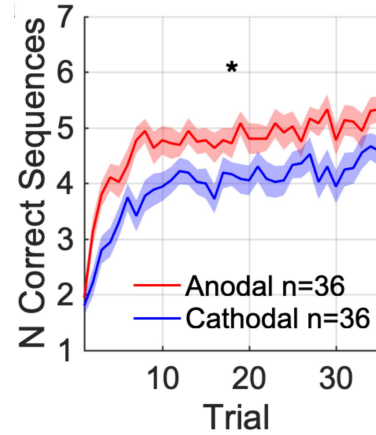
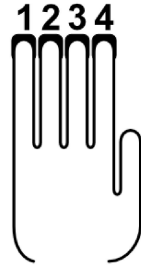


Sharma et al, Brain Stim 2022

Human motor learning experiment

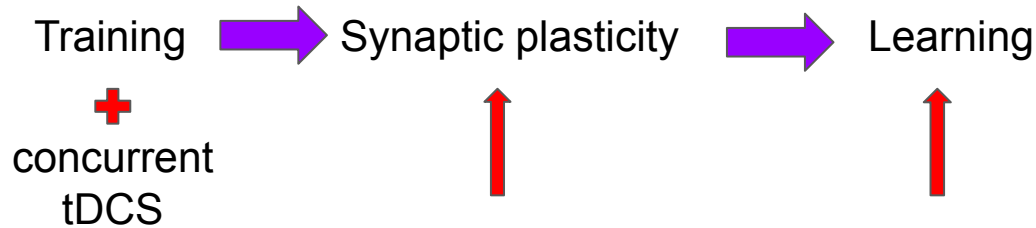


Floel et al. 2008, JCogNeuro

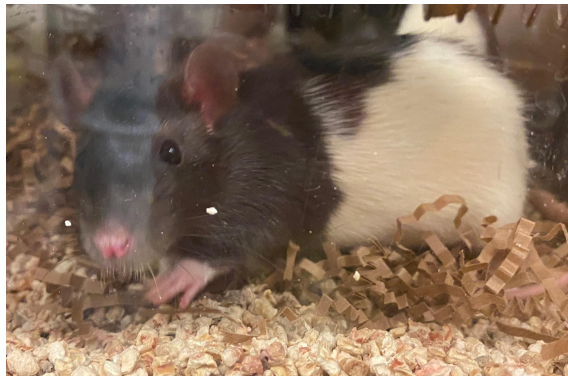
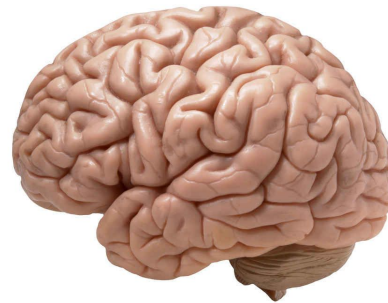
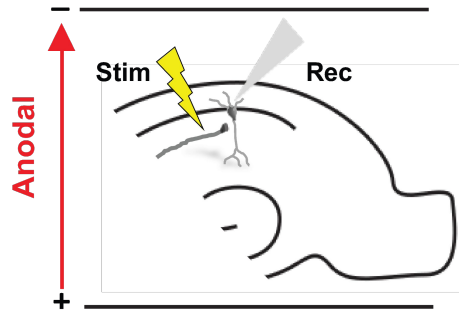


Hsu et al, BioRxiv 2022

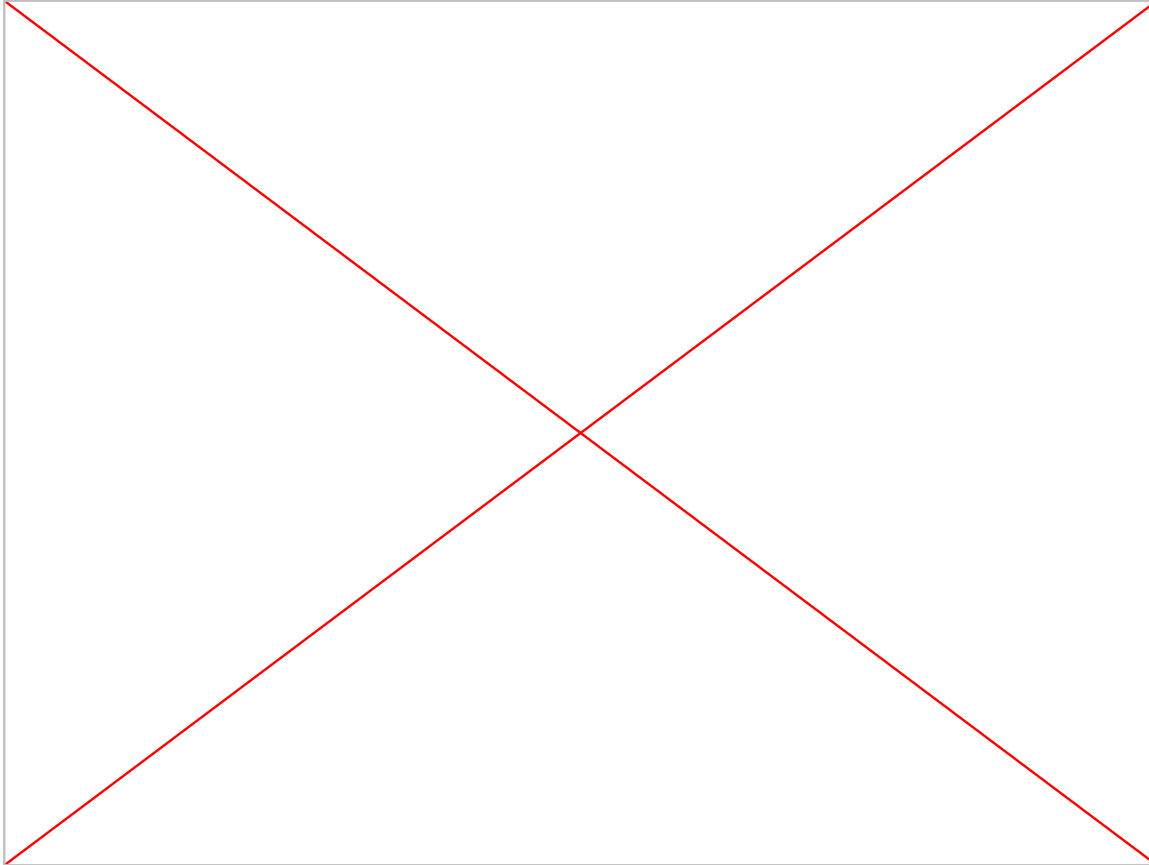
Check out B46



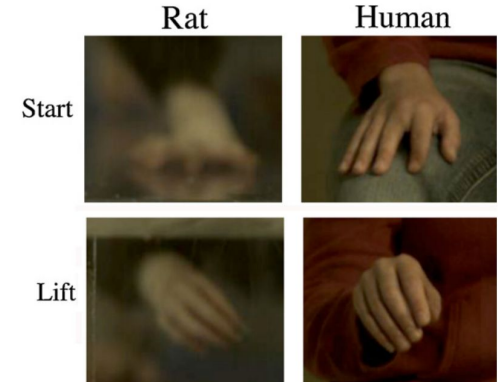
From in-vitro animal study to human



One promising application of tDCS is to modulate motor excitability and motor learning.



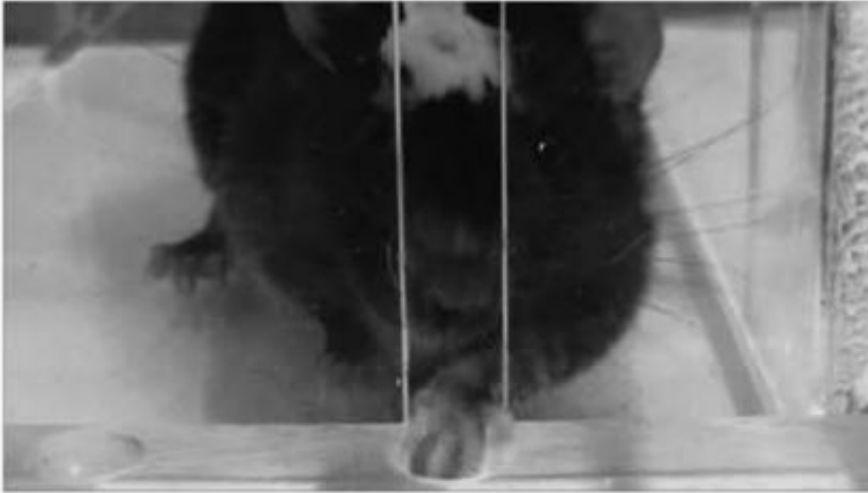
0.1xspeed



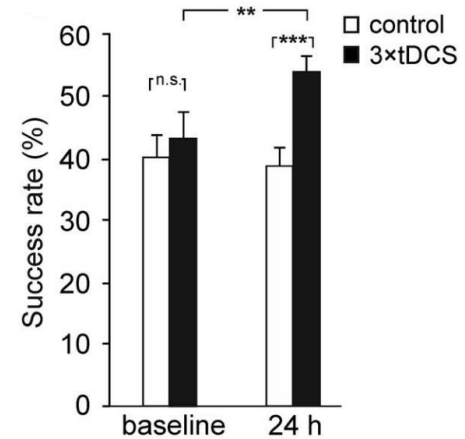
Sacrey et al, Behav Brain
Res 2009

tDCS and motor skill learning

❑ tDCS experiment in mice



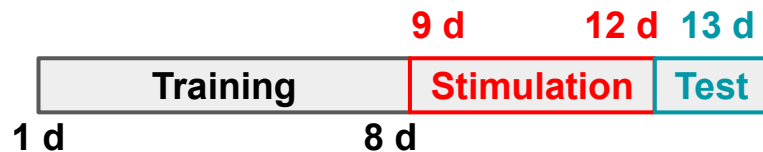
Barbati et al, Cereb Cortex 2020



Experimental design: tDCS

- Previous study (Barbati et al, 2020):

- Approx $E = 8 \text{ V/m}$



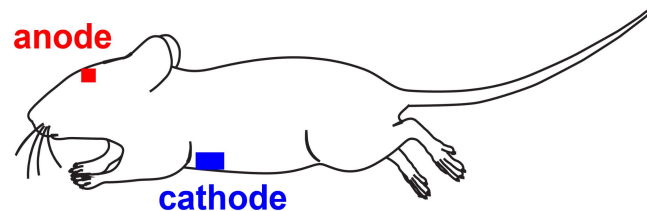
- Present work:

- $E = 2 \text{ V/m}$

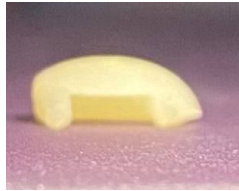
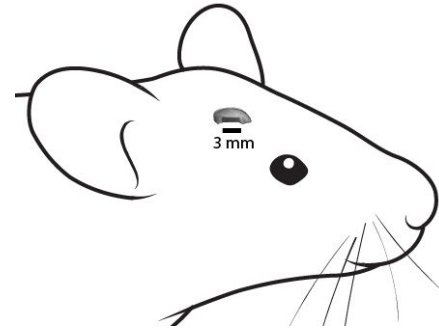
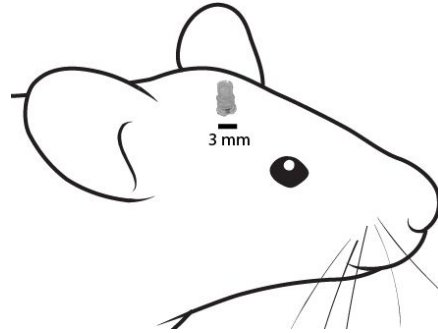
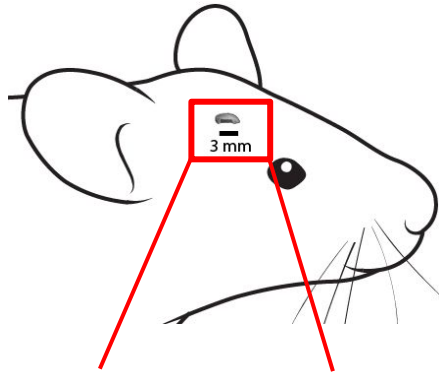


- Human experiments

- $E = 0.5 \text{ V/m}$



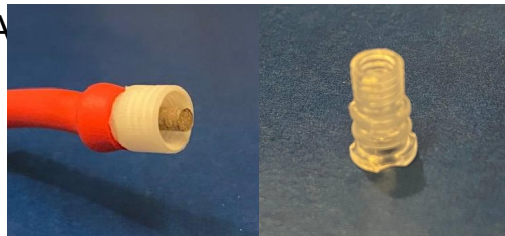
Technical development

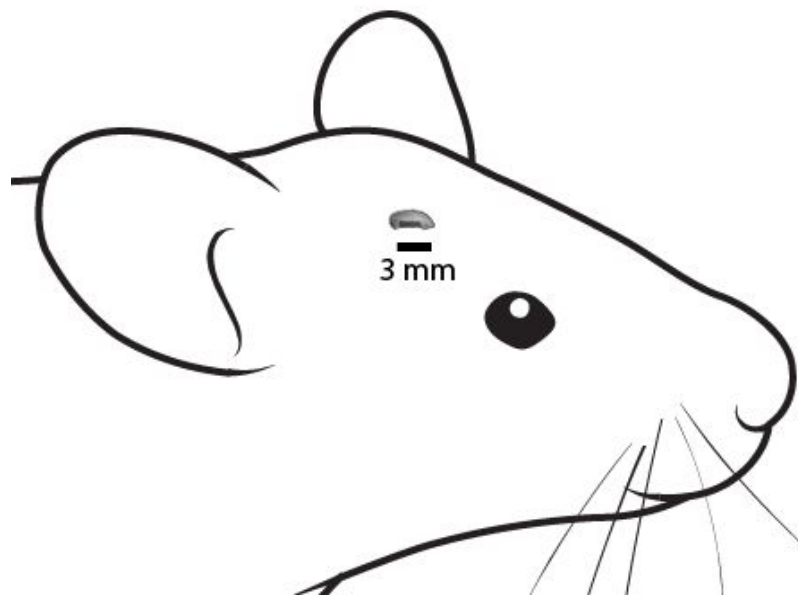


- Not stable current over 10 sessions



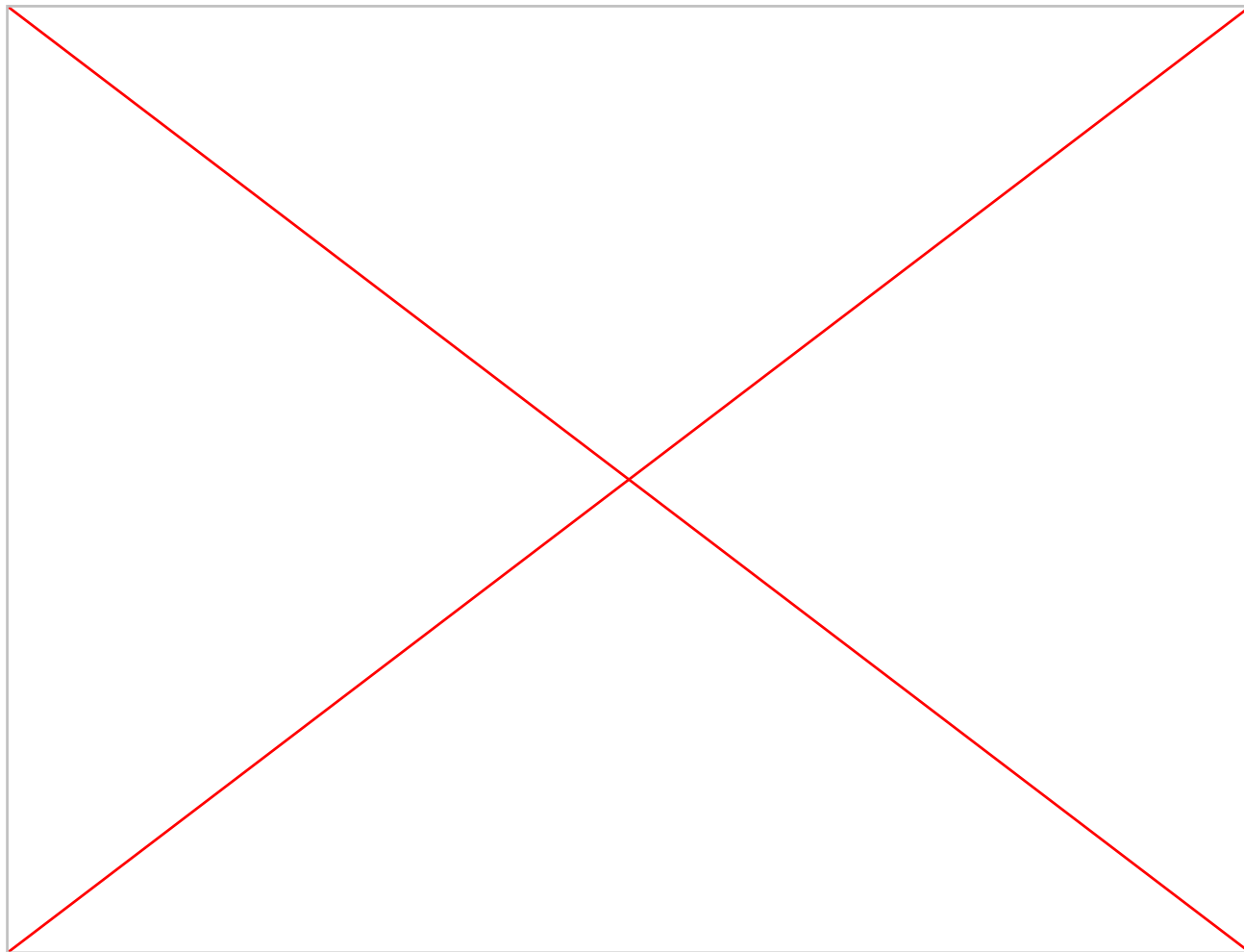
- Gel residual and infection
- A





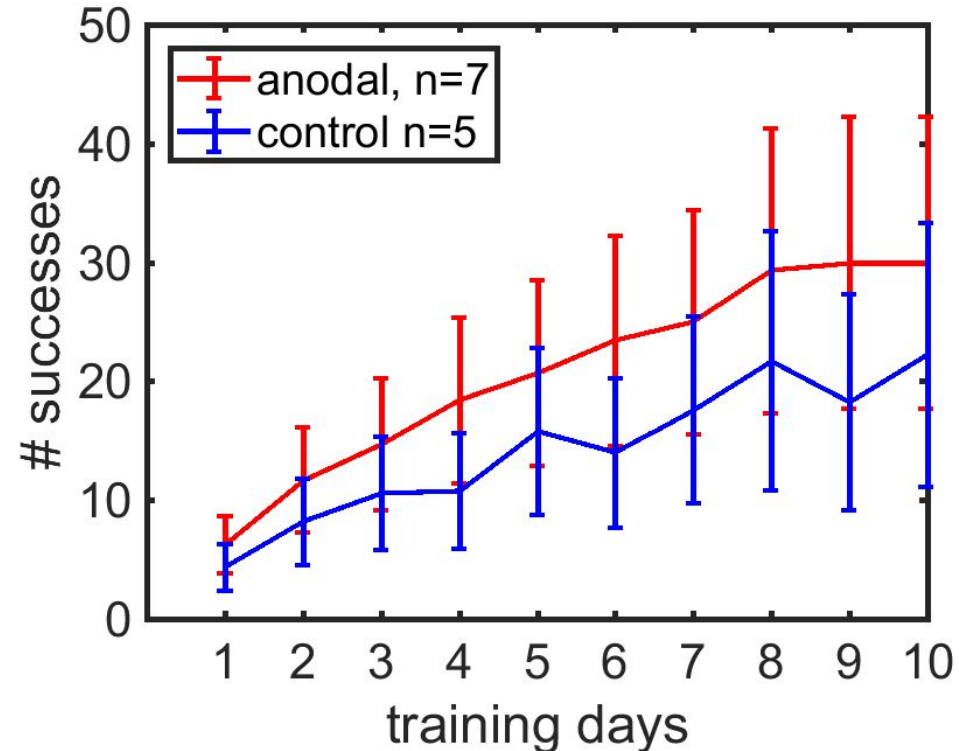
Behavior

2x speed



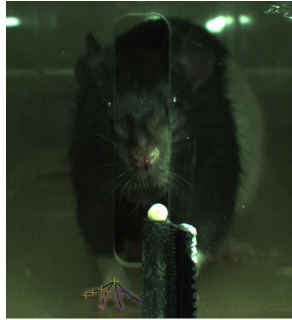
An interaction between days of training with stimulation condition

- A linear mixed effect model:
an interaction between days with stimulation condition
with an effect size of Cohen's $f=0.67$

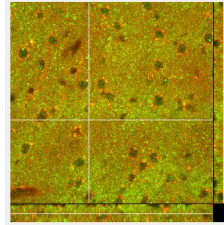


Future work

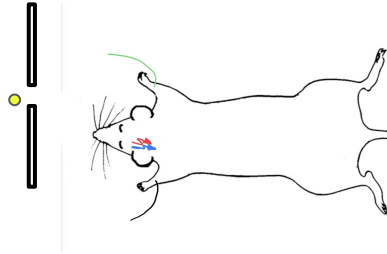
- ❑ Kinematic of Movement (DLC)

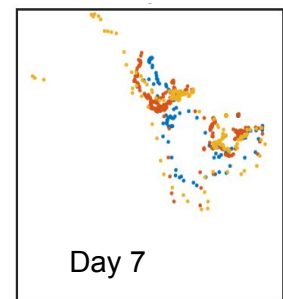
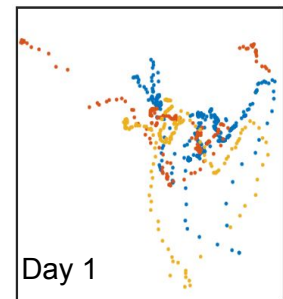
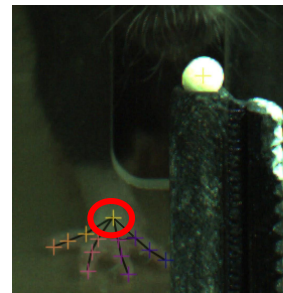
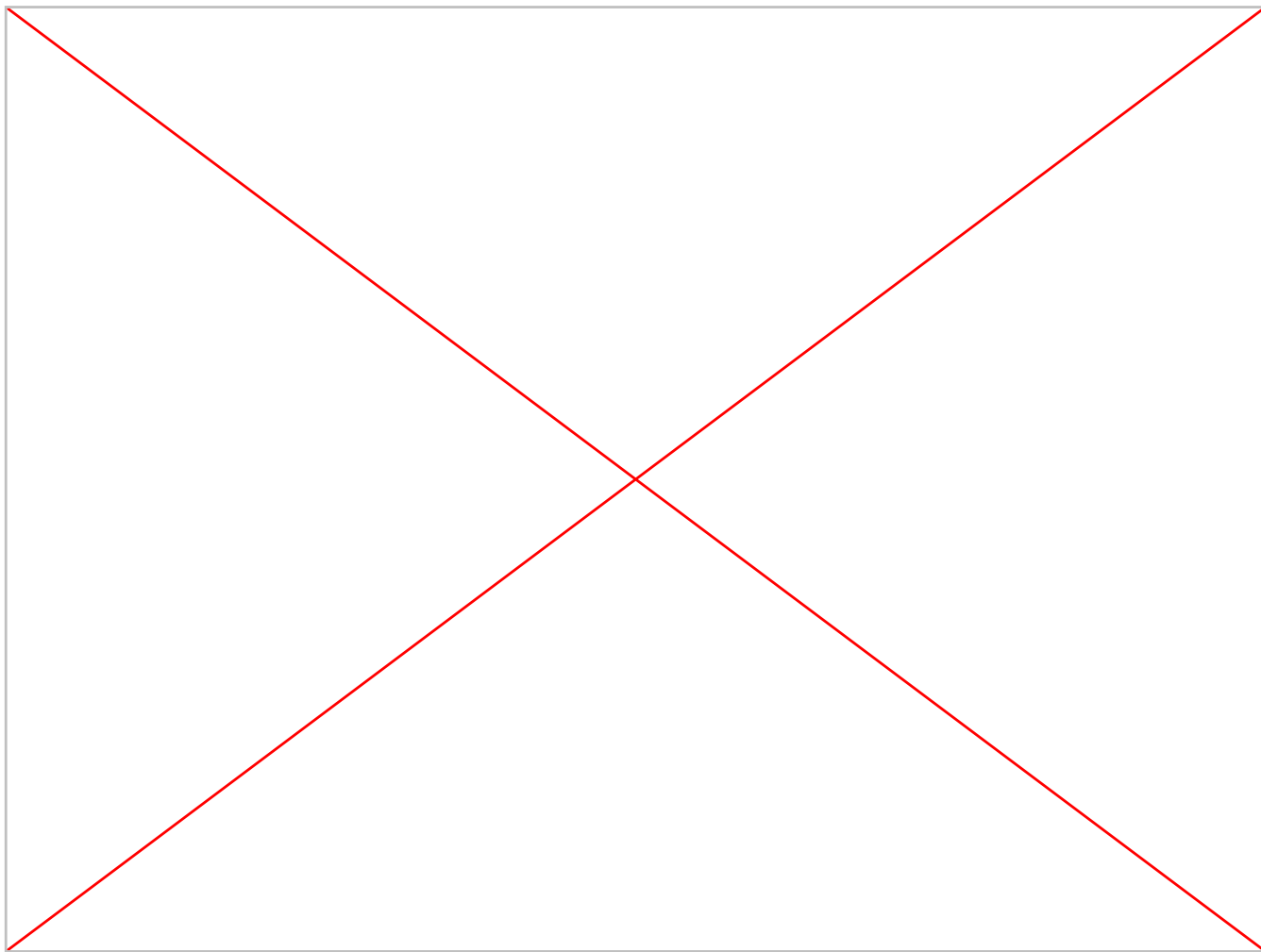


- ❑ Immunohistochemistry of synaptic marker

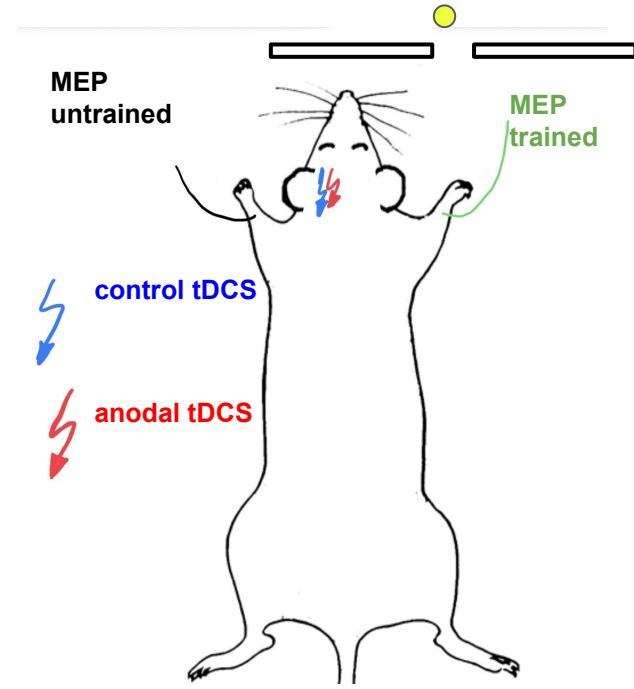


- ❑ MEP





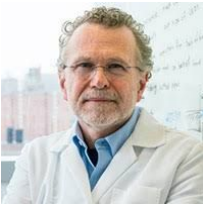
Motor Evoked Potential (MEP)



Conclusion:

- ❑ Bridging the gap between in-vitro and human experiments
- ❑ Concurrent tDCS with training across several days of training
- ❑ Accumulative effect of tDCS

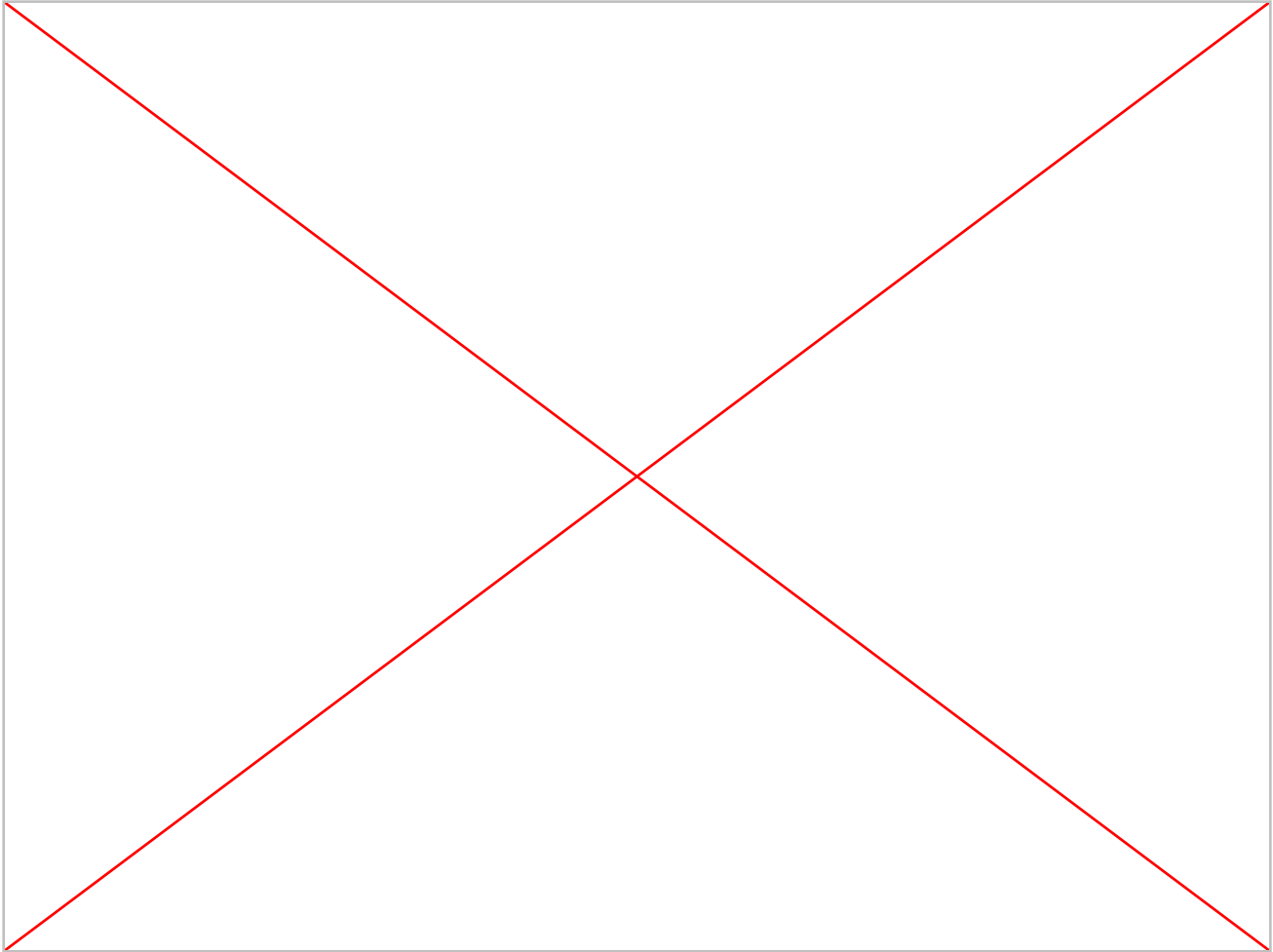
Thanks to



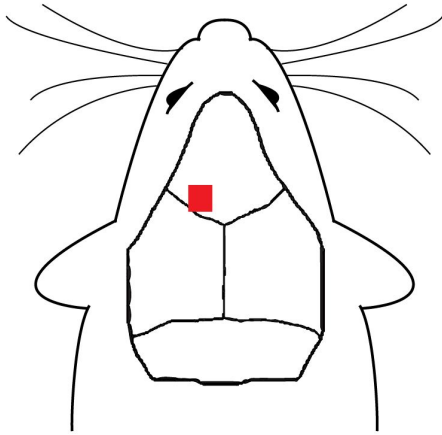
William Preston, Neela Zareen, Hisham Sharif,
Heather Alexander



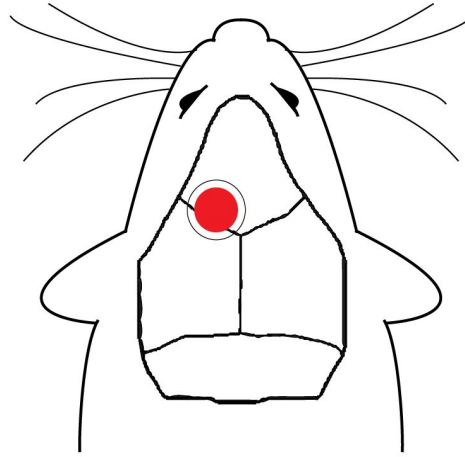
Behavior



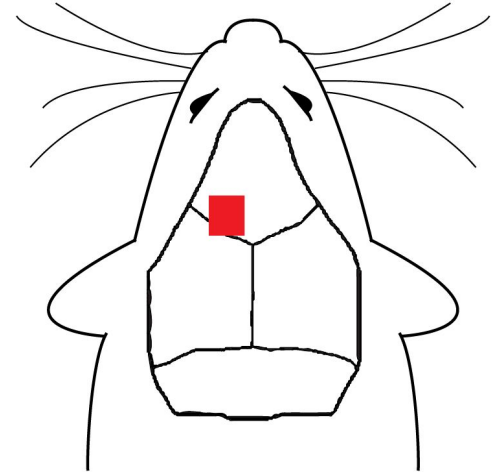
Technical issues



- Not stable current over 10 sessions



- Gel residual and infection
- Ag/AgCl electrode break

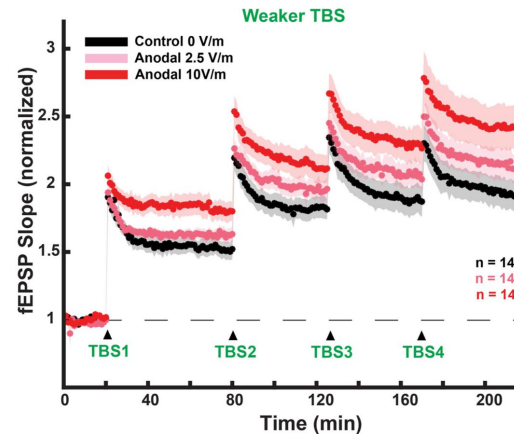
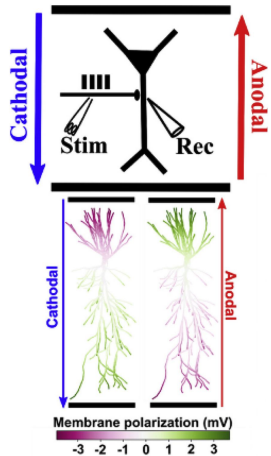


❑ **One important question:** do the effects of tDCS outlast the stimulation period?

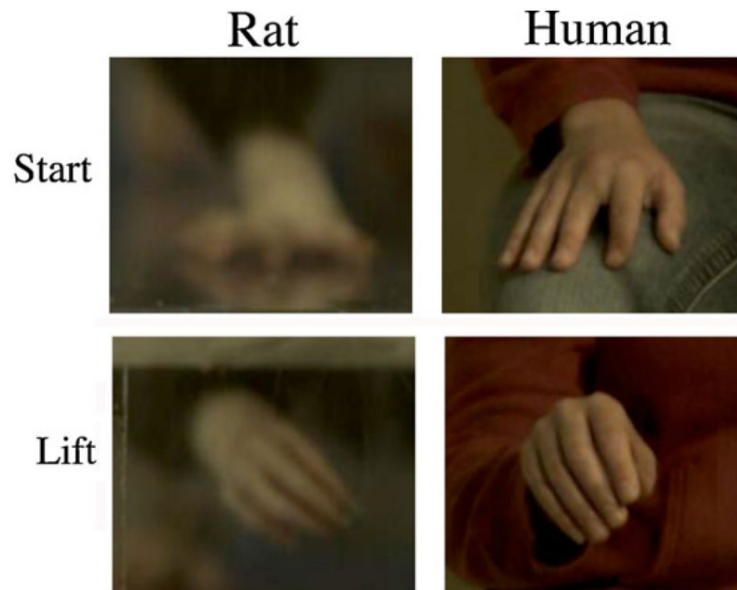
❑ Kronberg (Pathway specificity & associativity)

❑ Farahani (Somatic Spiking and LTP)

❑ Sherrin (small dose and accumulation)



Why reaching task?



Advance



Pronation



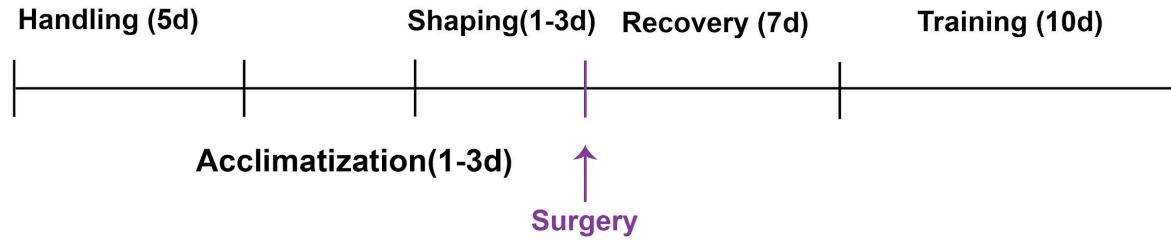
Grasp



Sacrey et al, Behav Brain Res 2009

Behavior

- ❑ Long-Evans Rat
- ❑ Timeline



Effects of tDCS on synaptic plasticity and motor skill learning

Barbati et al, 2020, Cereb Cortex

Mice

35.4 A/m² for 20 minutes

Threshold for microglia or astrocyte activation: 15.9 A/m²

