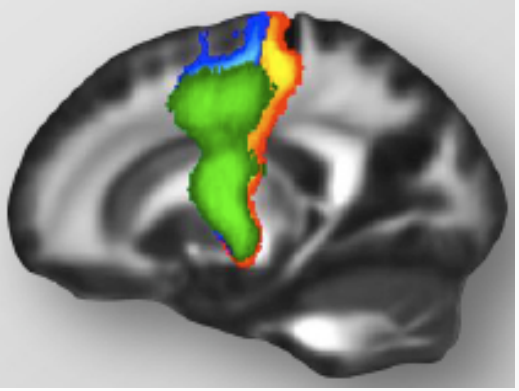


TRANSPORT2:

- Imaging -

Gottfried Schlaug, MD, PhD

Neuroimaging and Stroke Recovery Laboratory, Dept. of Neurology, Beth Israel Deaconess Medical Center/Harvard Medical School, Boston, MA

Contact: gschlaug@bidmc.harvard.edu

TRANSPORT2 Sites – MRI

MR machine and experience

UAB: Siemens Prisma 3T	Experience: yes
EmoryU: Siemens 3T	Experience: yes
UKentucky: Siemens Prisma 3T	Experience: yes
NRH/MedStar: Siemens Prisma 3T	Experience: yes
UCincinnati: Phillips 3T Achieva	Experience: yes
WashU: Siemens 3T	Experience: yes
Burke/Cornell: Phillips 3T Achieva	Experience:
MUSC: Siemens Prisma 3T	Experience: yes
UTexas: Phillips 3T	Experience: yes
USC: name/make?	Experience:
UPenn/Moss: Phillips 3T	Experience:
BIDMC/Baystate: Siemens 3T Skyra	Experience: yes

TRANSPORT2 Sites – MRI

MR machine and experience

UAB: Siemens Prisma 3T Experience: yes

EmoryU: Siemens 3T Experience: yes

UKentucky: Siemens Prisma 3T Experience: yes

NRH/MedStar: Siemens Prisma 3T Experience: yes

UCincinnati: Phillips 3T Achieva Experience: yes

WashU: Siemens 3T Experience: yes

Burke/Cornell: Phillips 3T Achieva Experience:

MUSC: Siemens Prisma 3T Experience: yes

UTexas: Phillips 3T Experience: yes

USC: name/make? Experience:

UPenn/Moss: Phillips 3T Experience:

BIDMC/Baystate: Siemens 3T Skyra Experience: yes

TRANSPORT2 Sites – MRI

MR machine and experience

UAB: Siemens Prisma 3T	Experience: yes
EmoryU: Siemens 3T	Experience: yes
UKentucky: Siemens Prisma 3T	Experience: yes
NRH/MedStar: Siemens Prisma 3T	Experience: yes
UCincinnati: Phillips 3T Achieva	Experience: yes
WashU: Siemens 3T	Experience: yes
Burke/Cornell: Phillips 3T Achieva	Experience:
MUSC: Siemens Prisma 3T	Experience: yes
UTexas: Phillips 3T	Experience: yes
USC: name/make?	Experience:
UPenn/Moss: Phillips 3T	Experience:
BIDMC/Baystate: Siemens 3T Skyra	Experience: yes

Preparing a Subject for MRI

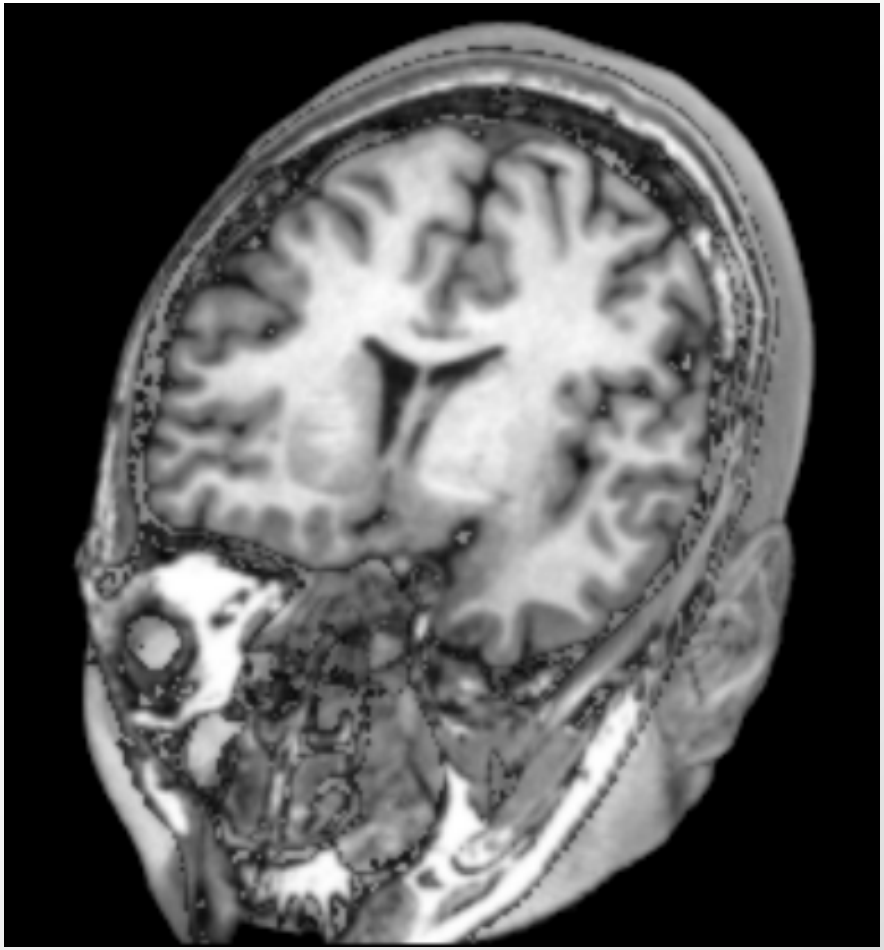
- MRI checklist: metallic, magnetic or electronic parts; rings, body piercings, watches, neckless; *magnetic hair products (iron, manganese, etc)*
- Documentation of any previous surgery that could have involved metals
- Ask whether your site might require participants to change into hospital gowns
- Pateint should use bathroom prior to scanning
- Patient should be as comfortable as possible
- Address claustrophobia with patient: keeping eyes closed helps; but eyes open during rs-fMRI

MR acquisition, Pre-Intervention

- **Comfortable:** foam padding, ear plugs, headphones, etc.;
- **MRI Markers** on C3 and C4 (10-20 system)

- **Sequences (Pre):**
- **T1**-weighted: 1x1x1; Lesion map; E-field; 4.5min
- **T2**-weighted: 1x1x1; Lesion map; E-field; 3.5min
- **FLAIR:** assess WMH; voxel:1x1x3mm; 4min
- **SWI:** assess microbleeds; voxel:1x1x2; 3 min
- **DTI:** at least 30 directions; voxel:2mm^3; 3.5min
- **rs-fMRI:**T2* (BOLD);TR3s;voxel: 2.5mm^3; 120 acqs; 6min

Examples of T1 and T2



T1 Image

T2 Image

MR acquisition, Post-Intervention

- **Sequences (Post):**
- **T1**-weighted: 1x1x1; lesion mapping; E-field; **4.5min**
- (**T2**-weighted: 1x1x1; lesion mapping; E-field); **3.5min**
- **DTI:** at least 30 directions; voxel?; **3.5min**
- **rs-fMRI: Eyes open!!** T2* (BOLD); TR3s; voxel 2.5mm^3; 36slices; 120 acq; 6min

Image uploading

- **MRI tech or MR physicist** will transfer images to you (usually compressed or gziped) via sftp or whatever your local process is.

- **Local PI/study coordinator** will upload images via WebDCU or local PI/study coordinator send images to WebDCU via sftp

- **Emergency exception:** send CDs to G.S. and I will try to upload.

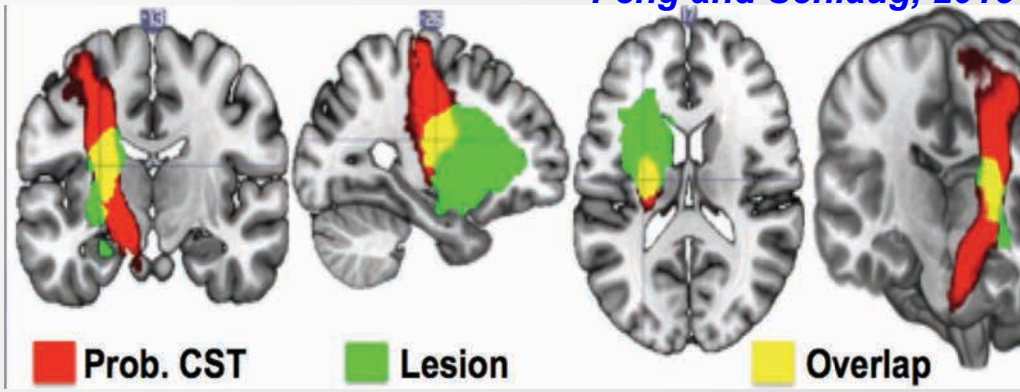
MR Image Analysis

- Lesion Mapping:

  Lesion Vol and wCST-LL

  Only Pre

Feng and Schlaug, 2015

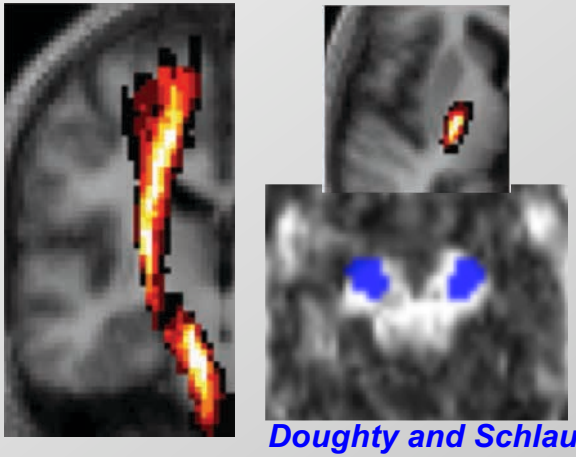


- Diffusion Tensor Imaging:

  FA in PLIC and Cerebral Peduncle

  (using the canonical CST for ROI definition)

  Pre and Post

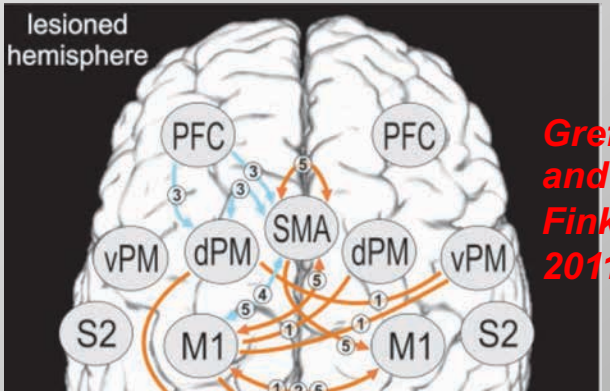


Doughty and Schlaug, 2016

- Functional Connectivity:

  les-**M1** and *c-les*-**M1** func. connectivity

  Pre and Post



Grefkes and Fink, 2011

Changes in Descending Motor Tracts

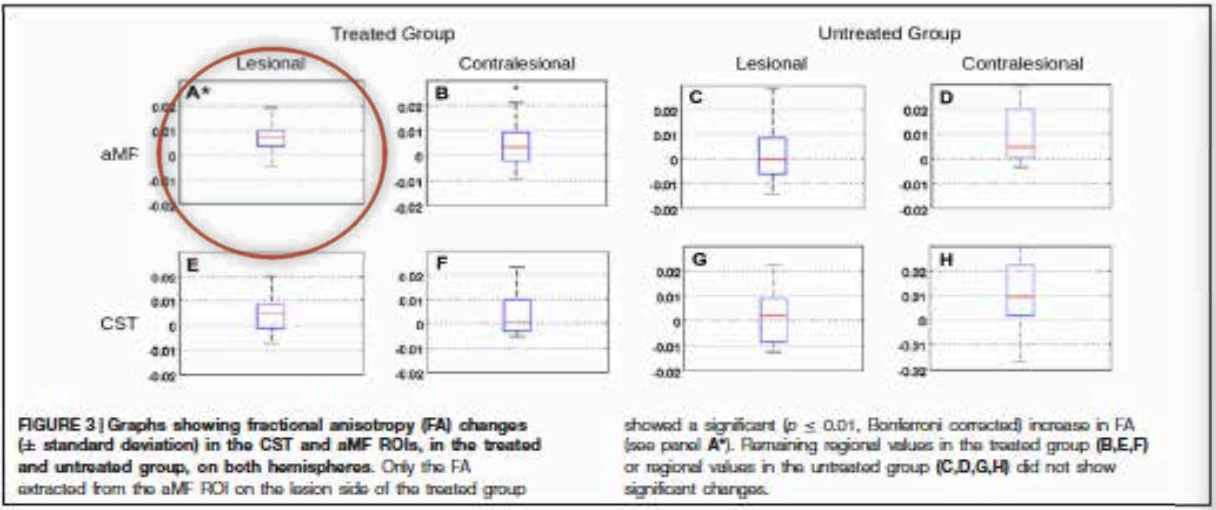
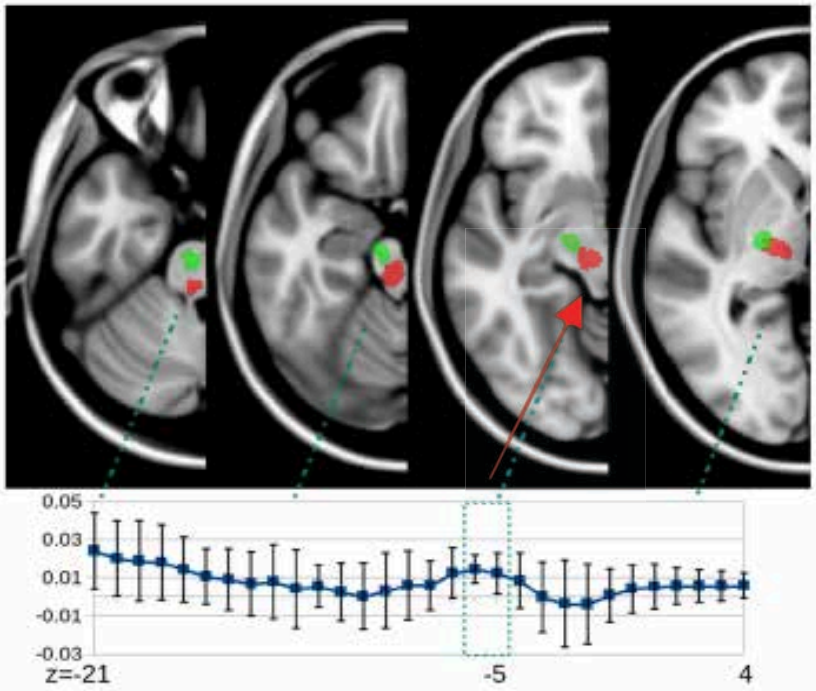
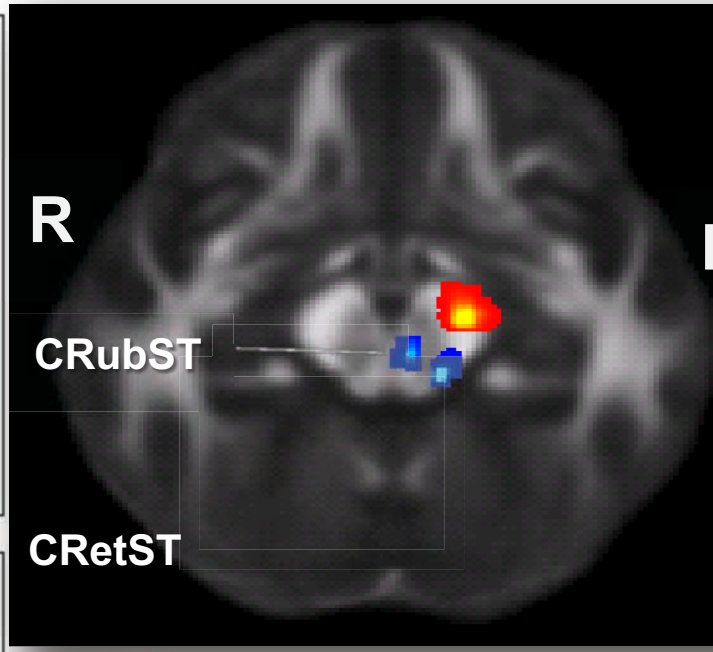
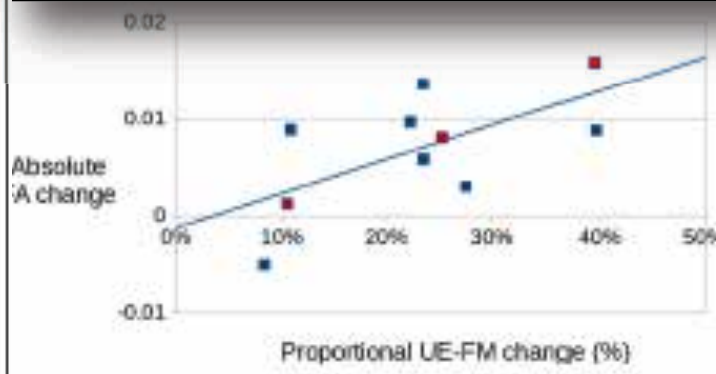


FIGURE 3 | Graphs showing fractional anisotropy (FA) changes (± standard deviation) in the CST and aMF ROIs, in the treated and untreated group, on both hemispheres. Only the FA extracted from the aMF ROI on the lesion side of the treated group showed a significant ($p \leq 0.01$, Bonferroni corrected) increase in FA (see panel **A***). Remaining regional values in the treated group **(B,E,F)** or regional values in the untreated group **(C,D,G,H)** did not show significant changes.



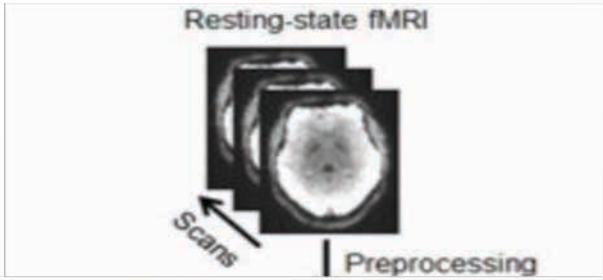


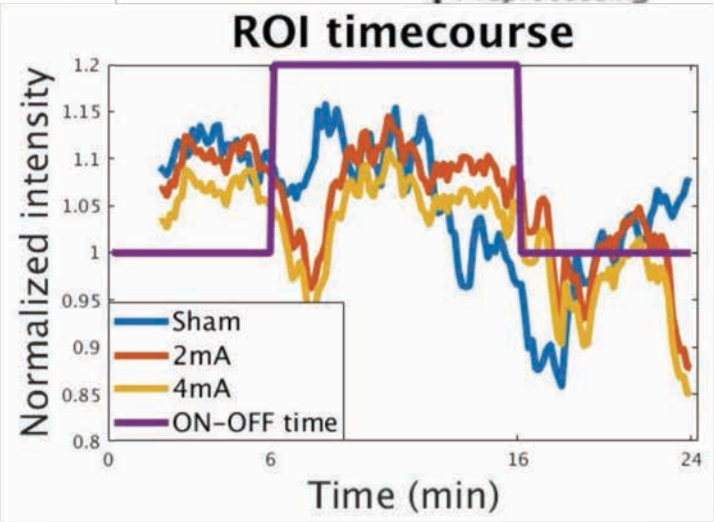


**GURE 5 | Correlation between changes in FA (obtained from the aM
the lesional hemisphere) and proportional changes in UE-FM in th
ated group ($r = 0.65$; $p < 0.05$).** Red dots are those from the diffusion
sor imaging (DTI) scan that used 30 directions. No differences were seen
tween the DTI sequences that used 25 directions and the one that used 3
ections.

Zheng and Schlaug, Front Neurosci20

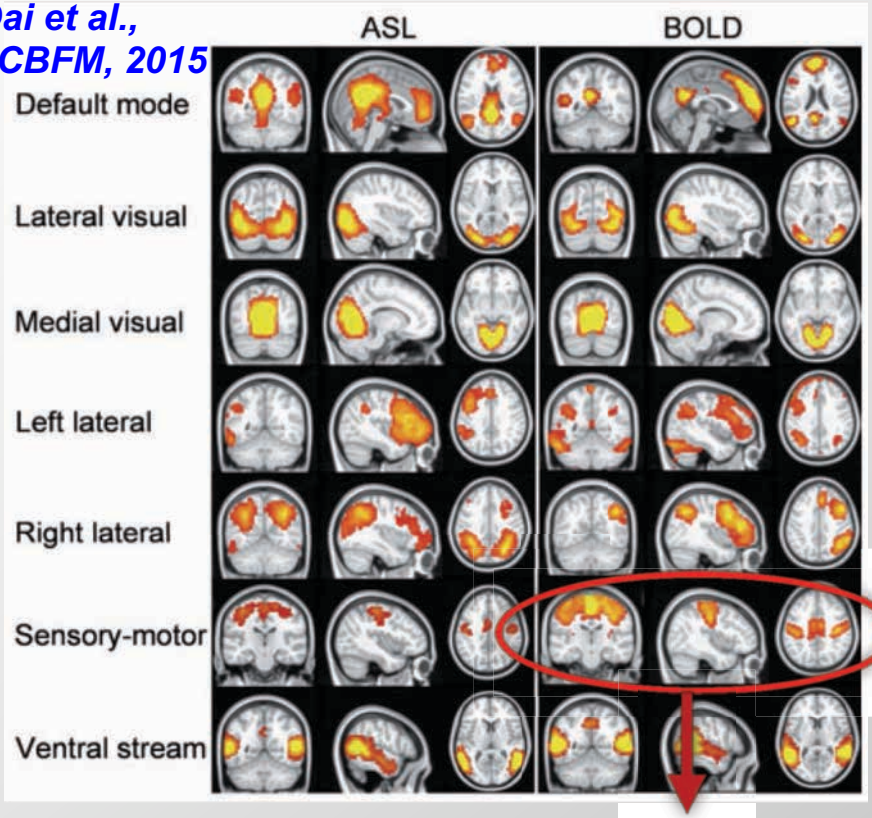
Resting State - fMRI

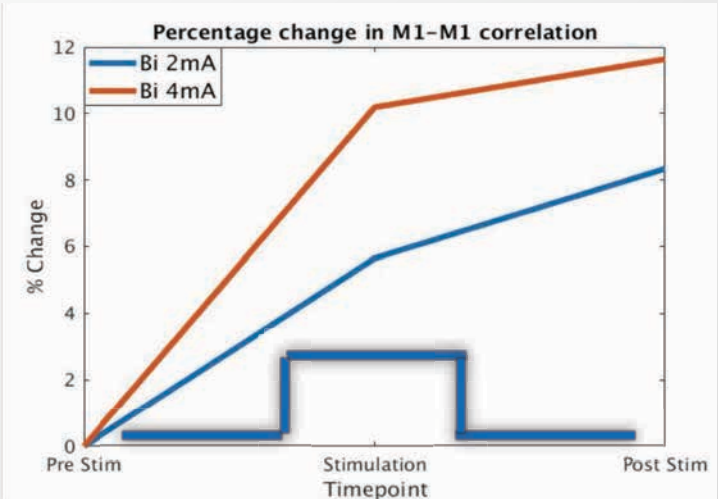




Can tDCS affect regional time-course?

Dai et al., JCBFM, 2015





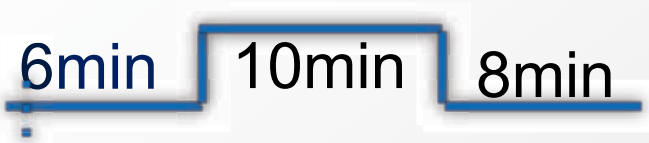
Can tDCS affect regional correlations?

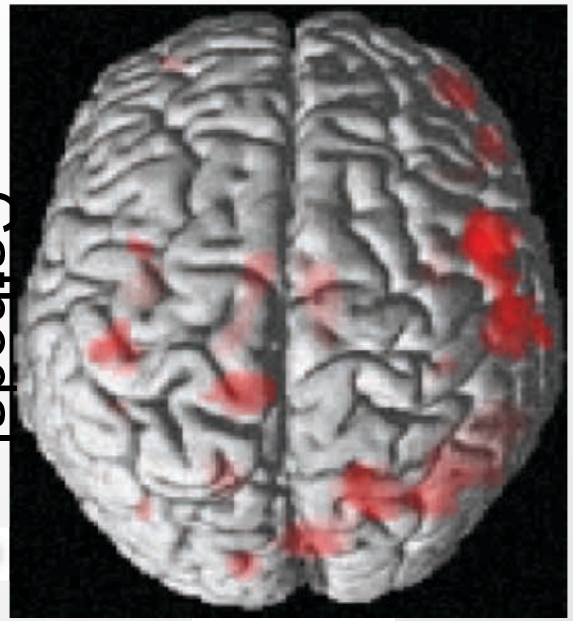
healthy M1 to M1: r=0.7

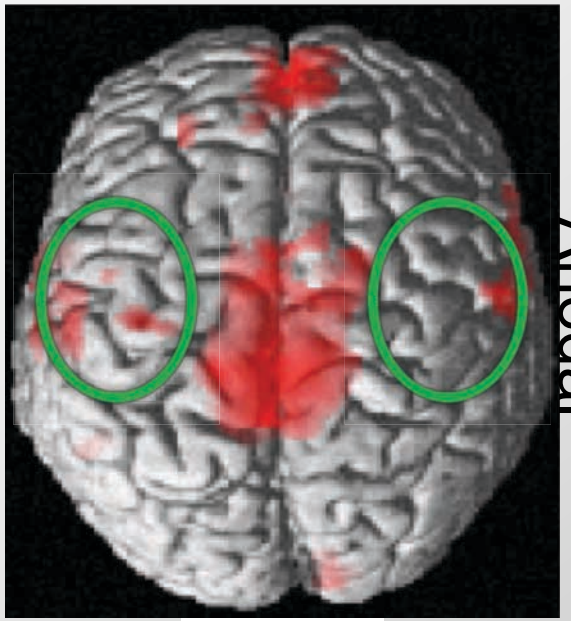
lesM1 to clesM1: r= 0.5

Current Enters the Brain and Changes Function

rCBF (ASL) Changes induced by tDCS



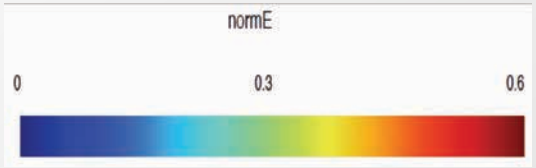


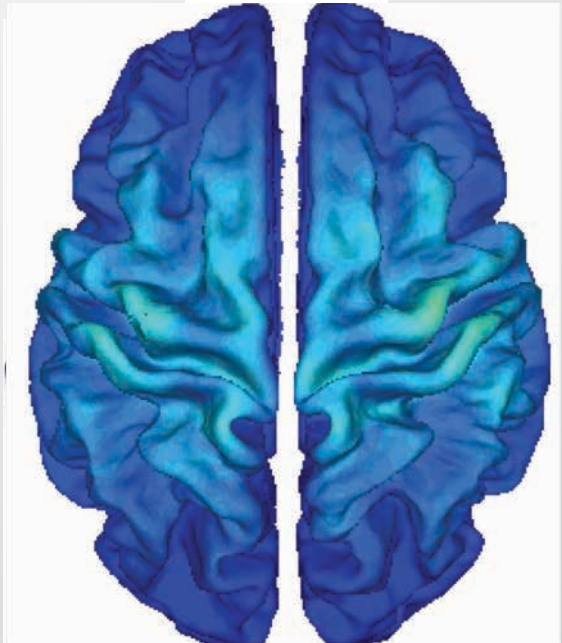


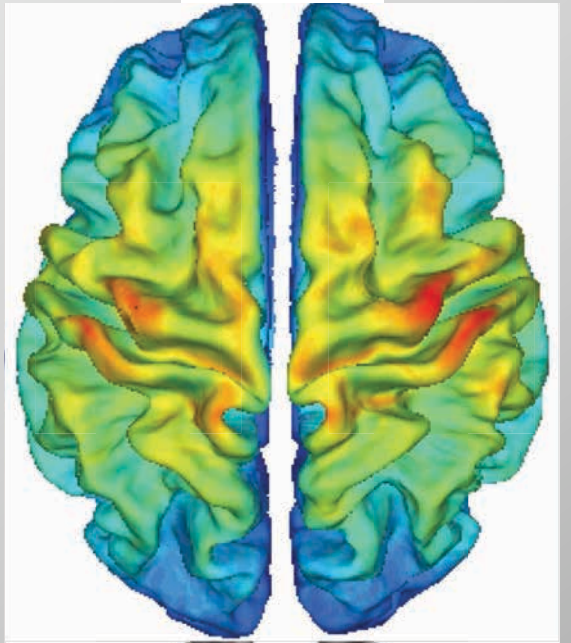
2mA

4mA

E-Field Simulation







Group Avg (n=10)

Conclusions

- Need to make sure that all sites have the appropriate **experience** to obtain MRIs before and after the intervention
- Siemens sequences are all set; still need to work on corresponding sequences for Phillips MRIs
- **CST-Lesion load variable is independent of scanner and field strength; every subject will contribute a value.** CST-LL strongly correlated with **impairment** and has been shown to be a **predictor of outcome after stroke.** CST-LL will be compared to TMS/MEP to assess predictive power.
- The microstructural status of **ipsi-lesional tracts (e.g., FA)** is related to **neurological impairment** in the chronic phase; we will test whether or not regional **FA** is a g**ood predictor of outcome and changes** (e.g., re-myelination or axon collaterals) in response to treatment.
- **Functional Connectivity** between *les*-**M1** and *c-les*-**M1 correlates with impairment** and can **change** with interventions. We will test whether or not functional connectivity between both motor regions predicts response to intervention and changes in response to intervention.
- A better understanding of **predictors** will help us understand the **mechanisms** of our interventions, **optimize** the intervention going forward, and could be used to **stratify** patients in future studies