Combining imaging with neuromodulation

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Neuromodulation provides tremendous control and flexibility – provided guidance for optimization.
Combining imaging with neuromodulation

A. Image guided targets for brain stimulation

B. Imaging informs mechanisms of brain stimulation
Image guided target for Brain Stimulation

1) Imaging identifies target
2) Brain stimulation changes target
Image guided target for Brain Stimulation

1) Imaging identifies target
2) Brain stimulation changes target

(?) A single target is identified across a patient population, circumscribed by a generic atlas.

(?) Both diagnosis and neuromodulation defined by a sliding-scale of brain function (e.g. dLPFC hypo-function is depression, stimulation dials activity back up to enhance mood).

(?) Protocols empirically determined with limited device innovation and mixed success.
Image guided target for Brain Stimulation

1) Imaging identifies target
2) Brain stimulation changes target

Automated, hypothesis-driven, individualized neuromodulation.
Imaging Anatomical  Functional

Tissue Segmentation
“Universal Solutions” (FEM)

Subject specific, target ambivalent

Computationally costly, technical, and dynamic

Target Selection (GUI)
Optimized Therapy (Stimulation Dose)

(1)

(2)
Automated, hypothesis-driven, individualized neuromodulation.

1) New algorithms for segmentation and brain stimulation optimization (Parra, Dmoschowski)

- Segmentation for device modeling
- Linear problems allow for rapid and “true” optimization
Automated, hypothesis-driven, individualized neuromodulation.

1) New algorithms for segmentation and brain stimulation optimization (Parra, Dmoschowski)

2) Computational Neurostimulation (beyond sliding scale)
Automated, hypothesis-driven, individualized neuromodulation.

1) New algorithms for segmentation and brain stimulation optimization (Parra, Dmoschowski)

2) Computational Neurostimulation (beyond sliding scale)

3) Verification and Validation
Automated, hypothesis-driven, individualized neuromodulation.

1) New algorithms for segmentation and brain stimulation optimization (Parra, Dmoschowski)

2) Computational Neurostimulation (beyond sliding scale)

3) Verification and Validation

4) Closed-loop targeting
Imaging Anatomical   Functional

Tissue Segmentation

"Universal Solutions" (FEM)

Subject specific, target ambivalent

Computationally costly, technical, and dynamic

Computationally light

Target Selection (GUI)

Optimized Therapy (Stimulation Dose)
Imaging informs mechanisms of brain stimulation

1) Online

2) Offline

Brain stimulation generates “fMRI” signal in the dead.

Online imaging during stimulation is not artifact free
Imaging informs mechanisms of brain stimulation

1) Online

2) Offline

DBS-relevant electric fields increase hydraulic conductivity of in vitro endothelial monolayers

S V Lopez-Quintero, A Datta, R Amaya, M Elwassif, M Bikson and J M Tarbell

Brain stimulation changes BBB function.

Online imaging during stimulation is not confound free
1) Online

Offline stimulation-simple design

2) Offline

Task-based fMRI

Subjects random allocation

group1

fMRI

Brain Stimulation

fMRI

Sham

fMRI

group2
Imaging informs mechanisms of brain stimulation

1) Online

2) Offline

Subjects random allocation

Task-based fMRI
Imaging informs mechanisms of brain stimulation

1) **Online**

2) **Offline**

*Subjective response craving rating*

**Completed tDCS imaging trial: Drug-addicts**
Imaging informs mechanisms of brain stimulation

1) Online

2) Offline

Offline stimulation-crossover-behavioral design

* Subjective response craving rating

Completed tDCS imaging trial: Drug-addicts
Imaging informs mechanisms of brain stimulation

Inter-individual difference

**tDCS effect**

**Planned Imaging Test ??**
Imaging informs mechanisms of brain stimulation

Conventional atlas based ROI

Neuromodulation effects based ROI

ROIs that predict individual response
Current flow models (used for brain stimulation device design) predict individualized targeting.
Correlating individual behavior, imaging, and brain stimulation targets
Combining imaging with neuromodulation

A. Image guided targets for brain stimulation

B. Imaging informs mechanisms of brain stimulation
NYC Neuromodulation 2017 Conference
January 13-15, 2017 (New York City, USA)
tDCS, EEG, HD-tDCS, tACS, DBS, ECT, SCS, Image guided neuromodulation

Speakers, Program, Registration Details: neuromodec.com

Abstract or 1-Page Proceedings Published in Brain Stimulation Journal – Due Nov. 1st, 2016

Over 50 international speakers presenting new data and technology
Over 200 attendees spanning academia, industry, clinic, government and regulatory

Scientific Conference Committee

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