Behavioral Intervention Research Using tDCS

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- Adaptive
- Plasticity
- Maladaptive

Promoting useful plasticity in motor cortex

Patient

Intervention

Patient + Intervention

Robotics for assessment of performance kinematics

TMS Demonstration

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

M. A. Nitsche and W. Paulus

![Image of graph showing MEP size over time with anodal and cathodal stimulation.](image)

"In order to induce aftereffects, a stimulus duration of at least 3 min at 1 mA or an intensity of 0.6 mA for 5 min"

Nitsche et al, 2000

Corticomotor excitability in stroke

![Image of brain diagram showing excitability changes.](image)

Functional Improvements

- sRT/cRT
- Pinch force acceleration
- fingers/thumb AROM
- Movement accuracy
- Purdue Pegboard
- JTT

TMS correlates

- Resting MT
- Transcallosal Inhibition
- MEP Amplitude
How does repetitive behavior affect motor cortex?

Simple repetitive finger movements increase excitability
How does combined intervention affect motor cortex?

Is coupling tDCS with training good?

Anodal tDCS combined with robotic motor training

Relevance of kinematic measures to clinical function

Movement Speed (peak, mean)

Movement Smoothness

Aim

Deviation

“Kinematic Robot-Based Evaluation Scales and Clinical Counterparts to Measure Upper Limb Motor Performance in Patients With Chronic Stroke” (Bosecker et al, 2009)
### Movement Training Paradigm

**Visual Cue & Feedback**

- Hand position: neutral (active), extension (passive), machine passive, robot active.

- 20 mins, 0.2Hz movement (4 mins move, 1 min rest) x 4

### Key Findings: Effect of Intervention on Motor Performance

**Giacobbe et al., (2013)**

- **Group Data n=12**

**Training Period**

- 3x/wk, 12 weeks, 36 sessions
- 1 hour shoulder/elbow/wrist robotic training
- tDCS or sham pre-training (2 groups)

**H1:** Robot + tDCS > Robot + sham tDCS on UEFM improvement

- 82 patients, right hemiparesis
- >6 months post first ischemic stroke
- Robotic protocol alternates S/E-wrist robot across sessions
- tDCS 2mA, 35cm² 0.9% NaCl soaked sponges

### Timing of tDCS and Behavioral Therapy

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<td>rTMS</td>
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### FM Scores (max 70)

- 6 months post stroke
- Usual care
- 5/5: Intensive Comparison Therapy (ICT)

- 36 session protocol chronic stroke

**Lo et al, NEJM (2010)**
tDCS for aphasia rehabilitation
• primarily studied as a complement to speech therapy

Northstar Trial
• Parameters:
  • 2 runs of 20 minutes of cathodal stimulation
  • Electrode placement
    • Cathode – R pars triangularis
    • Anode – L supraorbital region
  • Real – direct current of 2 mA
  • Sham – direct current of 0.1 mA
  • Worn during speech therapy

Edwards et al. Accepted
Physical presence of DC field in human tissue with tDCS
(magnitude v time)

Net Biological response to DC field in human tissue with tDCS
(MEP amplitude v time)

Note: Theoretical

Lasting effect
Stroke subtype and motor impairment influence contralesional excitability

Webster et al (2006)

NeuroMeasure: a software package for quantification of cortical motor maps using frameless stereotaxic transcranial magnetic stimulation


https://github.com/EdwardsLabNeuroSci/NeuroMeasure

* Gerber et al 2019

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Thank you