Non-Invasive Brain Stimulation and Behavioral Therapy

Considerations

Dylan J Edwards PhD
Assistant Professor of Neurology

Limitations and advantages of restorative methods....?

Pharmacology  Brain Stimulation  Behavioral Intervention

Smaller Coil  Focality / Specificity  Network activation

Adaptive  Plasticity  Maladaptive

How does repetitive behavior affect motor cortex?
Simple repetitive finger movements increase excitability.

Motor map changes with skilled practice.

How does NIBS affect motor cortex?
“An excited neuron tends to decrease its discharge to inactive neurons, and increase this discharge to any active neuron, and therefore to form a route to it, whether there are intervening neurons between the two or not. With repetition, this tendency is prepotent in the formation of neural routes”.

(Hebb, 1932, p.13).

The Organisation of Behaviour: A Neuropsychological Theory. D.O. HEBB (1949)
How does combined intervention affect motor cortex?

Is coupling NIBS with therapy good?

**Altering cortical excitability before repetitive synaptic activity**

- tDCS at 1mA 10mins tDCS
- rTMS at 5Hz 100stim train at AMT – decreases SICI, but not lasting change in excitability as tested by single pulse TMS
- Result: after effects of tDCS can generate opposite effects of rTMS or conversely can alter the after effects of tDCS


Motor systems example

If...

Motor Training = improvement in function ‘X’

and...

tDCS = improvement in function ‘X’

does...

Motor Training + tDCS = improvement in function 2X, X², or 0??
Anodal tDCS combined with robotic motor training


Kinematic measures v 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” (Boscker et al, 2009)

NIH funded study 2012-2017 – tDCS and robotic motor training in stroke

Combined tDCS-Robotic Training Study Design

Training Period

3x/wk, 12 weeks, 36 sessions

1 hour shoulder/elbow/wrist robotic training

IDCS or sham pre-training (2 groups)

CLINICAL, KINEMATIC, NEUROPHYSIOLOGY EVALUATION

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

Upper limb robotics at Burke-Cornell, New York

Robotics with brain stimulation in patients with motor dysfunction

Superior functional gains with Nexstim NBT

Navigation makes a difference; Upper extremity Fugl-Meyer scores

Prelim data for Nexstim NICHE Trial 2014
Other cortical areas?

Conclusions

- Brain state influences the response to neuromodulation
- Homeostatic mechanisms may oppose further enhancement when interventions are combined
- Combined neuromodulation & behavioural therapy can be effective
- The optimal circumstances require further investigation