Effects of sham-controlled double blind transcranial direct current stimulation in patients with disorders of consciousness

XXth World Congress of Neurology
Marrakesh, Morocco
16 November 2011

THIBAUT Aurore PhD candidate

Coma Science Group
Cyclotron Research Centre & Neurology Dept & University Hospital of Liège
Belgium
Patients

NORMAL CONSCIOUSNESS

AROUSAL

AWARENESS

COMA

AROUSAL

AWARENESS

VEGETATIVE STATE/UNRESPONSIVE WAKEFULNESS SYNDROME

AROUSAL

AWARENESS

MINIMALLY CONSCIOUS STATE

AROUSAL

AWARENESS

Laureys, Owen and Schiff Lancet Neurology, 2005
Laureys et al, BMC Medicine 2010
Why direct current stimulation?

### Stimulation | Population | Effects | Authors
--- | --- | --- | ---
Prefrontal cortex | Healthy subjects | Memory | Marshall et al, J Neurosci 2004
 | Alzheimer’s patients | Memory | Ferrucci et al, Neurology 2008
 | Aphasic patients | Language | Baker et al, Stroke 2010

- Non-invasive
- Easy to apply
- Cheap equipment
AIM of the study

To assess tDCS effects on cognition in patients with disorders of consciousness
Methods

- **Design:** sham-controlled double blind
  - 4 CRS-R: pre-post tDCS/pre-post sham

- **Patients**
  - 55 patients (16 women; aged 43 ± 18 y)
  - 25 VS/UWS, 30 MCS
  - 25 traumatic / 30 non-traumatic

- **Outcome measure**
  - Coma Recovery Scale-Revised (CRS-R, Giacino 2004)

- **Hypothesis: tDCS responders:**
  - CRS-R total tDCS > pre-tDCS, sham, pre-sham

- **Statistical analysis:** ANOVA (Stata)
Group data (n=55)

**Interactions**
- MCS>VS, p=0.026
- Acute> chronic, p=0.004
- Etiology, p=0.37
VS/UWS vs. MCS

VS/UWS

MCS

17 responders
- 15 MCS (7 acute, 8 chronic)
- 2 VS/UWS (acute)
Conclusions

- Deep Brain Stimulation (Schiff et al., Nature 2008)

- Amantadine (Schnakers, 2008)

- Non-invasive non-pharmacological class A evidence for tDCS induced cognitive improvement in MCS
THANK YOU

Questions to: athibaut@chu.ulg.ac.be

www.comascience.org
Responders

25 VS/UWS → 2 responders
2/11 VS/UWS acute
0/14 VS/UWS chronic

30 MCS → 15 responders
7/9 acute
8/21 chronic
Responders: audition subscale

- Consistent movement to command
- Reproducible movement to command
- Localisation of sounds
- Auditory startle
- None

Pre tDCS vs Post tDCS vs Pre sham vs Post sham

* indicates significant difference
Responders: subscales - visual

- Object recognition
- Reaching
- Visual pursuit
- Fixation
- Visual startle
- None

Comparison between pre tDCS, post tDCS, pre sham, and post sham conditions.
tDCS parameters and safety

Intensity: 2mA
Time: 20 minutes
Voltage: max 26V
Electrodes: 35cm²
Max: 0.1mA/cm²

\[ U = R \times I \]

2mA and 10kOhm
= 20V OK

2mA and 20kOhm
= 40V STOP
tDCS presumed mode of action

**Direct effects**
Modification of neuronal excitability

**Long term effects**
Modification of ion channels ($\text{Na}^+, \text{Ca}^{2+}$)
Modification of NMDA receptors efficacy
Modification of inter-neurons

still hypothesis

Nitsche et al., J Physiol 2000
Nitsche et al., Neuroscientist 2010
tDCCS criticisms

Limitations:

- Short term effect
- Moderate clinical change
- Unknown physiological effects (cathode)
- Improve electrode position?