Transcranial direct current stimulation in patients with disorders of consciousness

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Introduction

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Why direct current?

Stimulation	Population	Effects	Authors
Motor cortex	Healthy subjects	Dexterity	Boggio et al. Neurosci Lett, 2006
	Hemiplegic patients	Dexterity and strength	Hummel et al. Lancet, 2006
	Spastic patients	Spasticity & ADL (activity of daily life)	Wu et al., Arch Phys Med Rehabil 2012
Prefrontal cortex	Healthy subjects	Memory	Marshall et al. J Neurosci, 2004
	Alzheimer's patients	Memory	Ferrucci et al. Neurology, 2008
	Stroke patients	Attention	Jo et al. Am J Phys Med Rehabil, 2009
	Aphasic patients	Language	Baker et al. Stroke, 2010

Method

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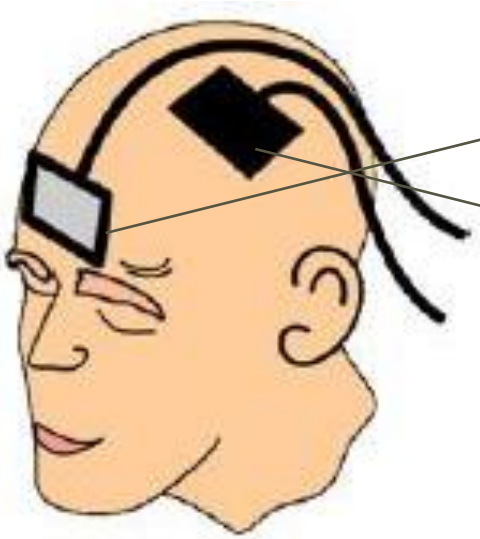
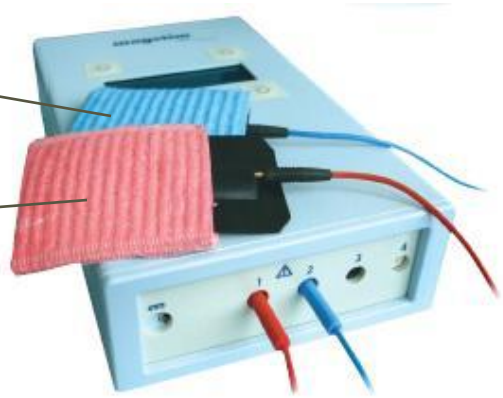
Methods



Cathodal

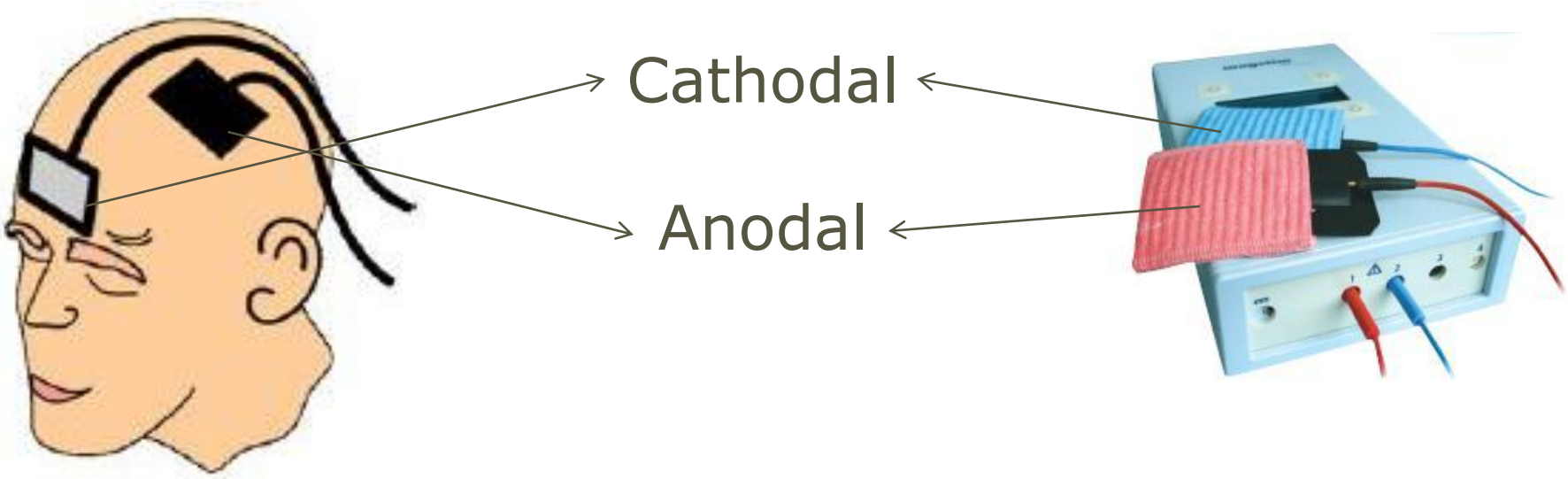
Anodal



- Direct current
- 2 mA
- 20 minutes

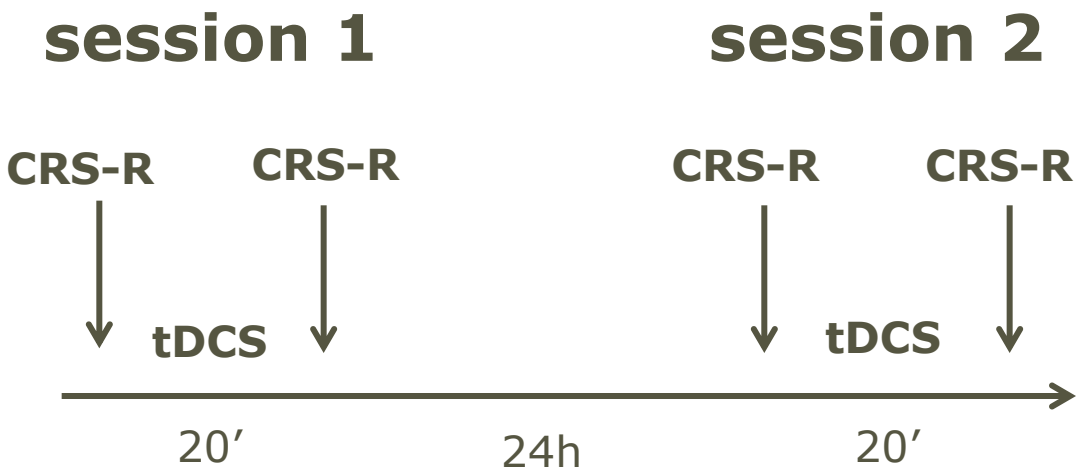
Randomised
double blind
sham controlled

Methods



Assessing the effect of **tDCS** on cognition in patients with DOC

Methods



Responder : CRS-R total post tDCS > pre-tDCS
> sham
> pre-sham

Results

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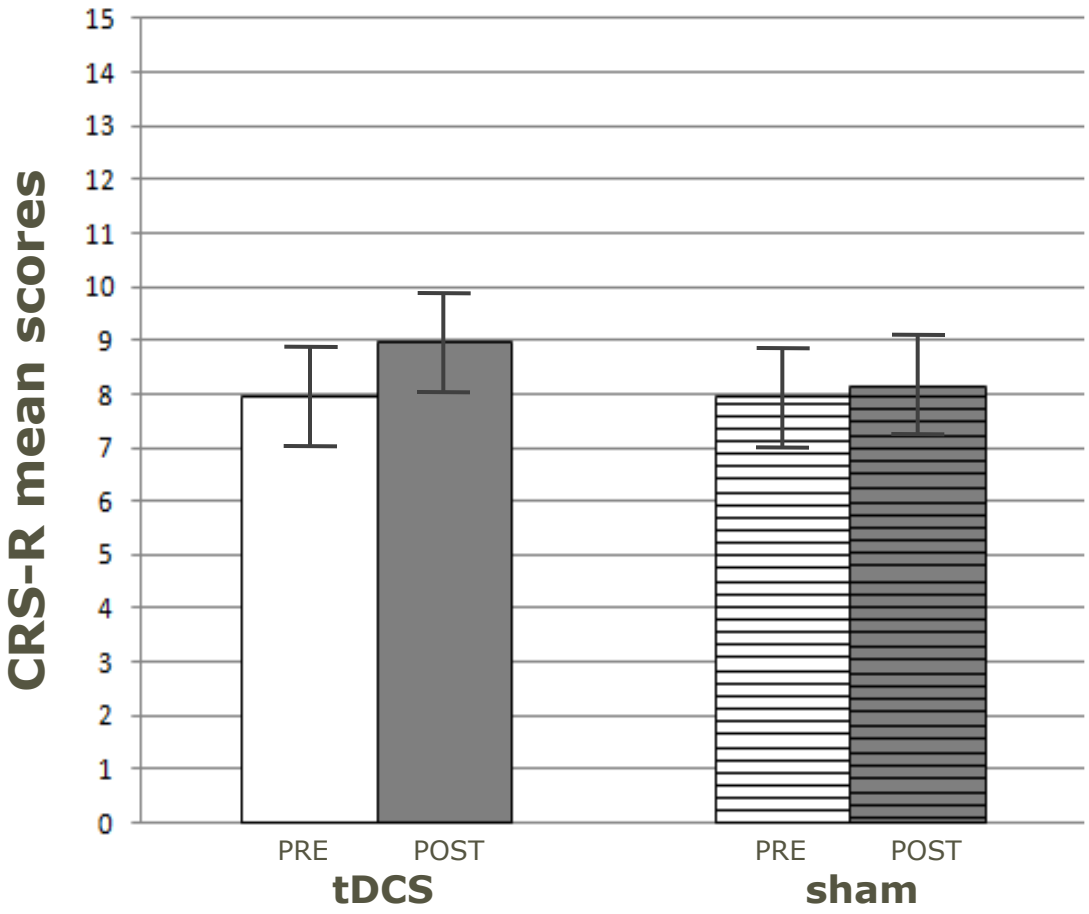
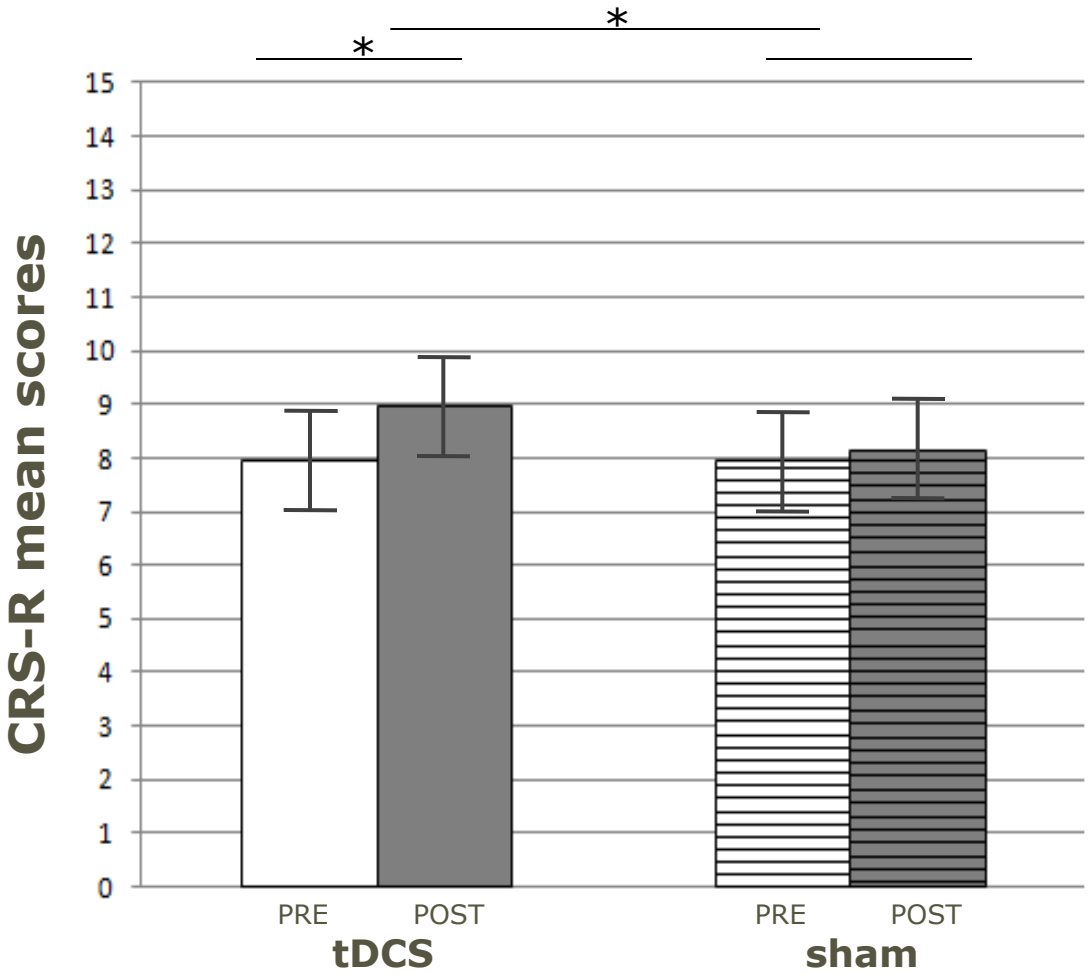
Group results



- 55 patients (43 18y)
- 25 VS/UWS, 30 MCS
- 25 TBI / 30 non-TBI
- 20 acute / 35 chronic (>3 months)

Group results



- 55 patients (43 18y)
- 25 VS/UWS, 30 MCS
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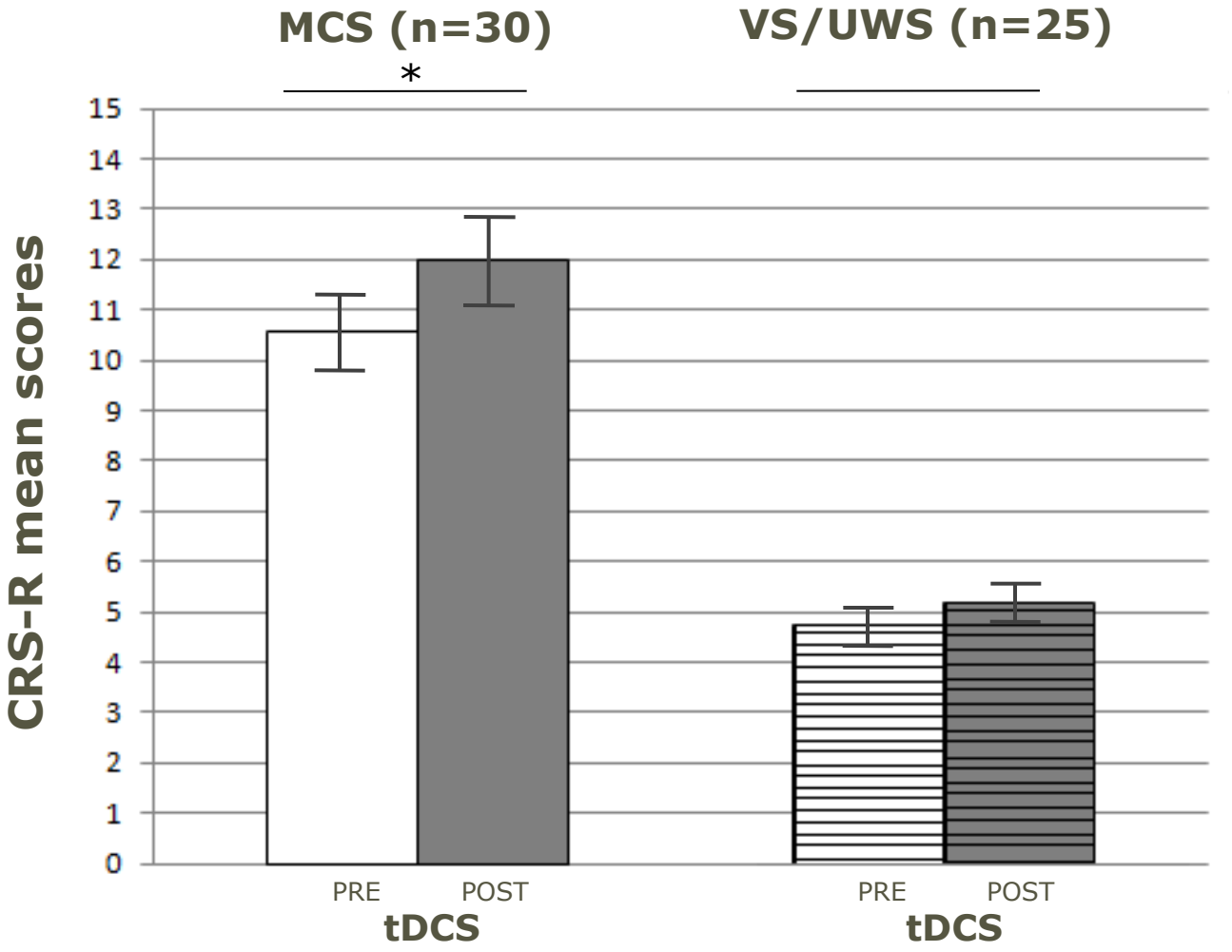
17 responders

- 2 UWS; acute
- 15 MCS; 7acute/8chronic

UWS/UV vs MCS


MCS (n=30)
VS/UWS (n=25)
*
CRS-R mean scores
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
PRE
POST
tDCS
PRE
POST
tDCS

Discussion

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tDCS presumed mode of action

Short term effects (Nitsche et al., J Physiol 2000)

Modification of neuronal excitability (action potential)

Long term effects (Nitsche et al., Neuroscientist 2010)

Action on opening of ion channels (Na^+, Ca^{2+})

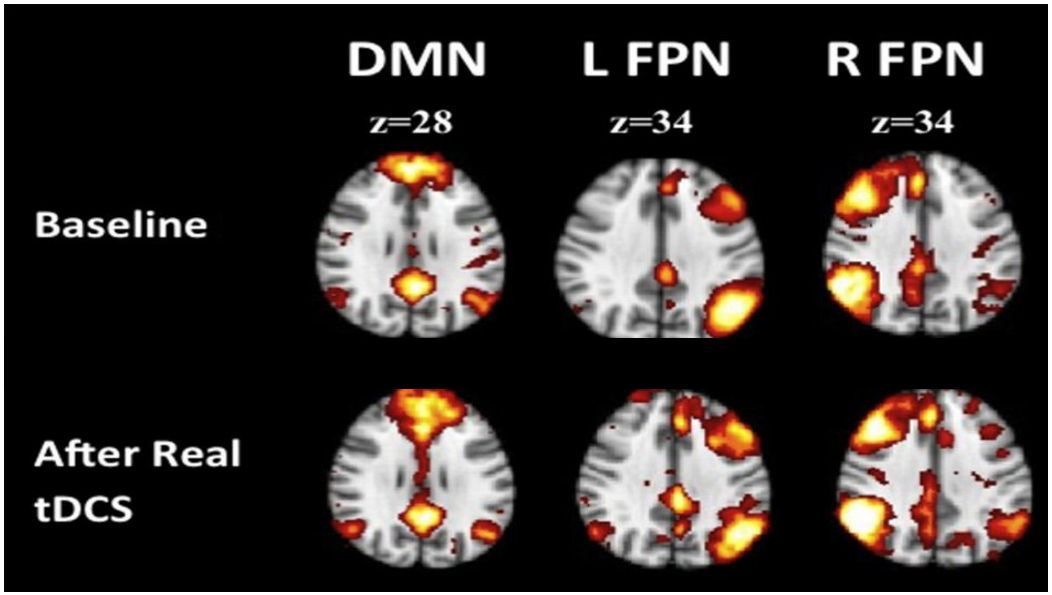
Increase NMDA receptors excitability

⇨ improve neuron excitability

Neurophysiology

Prefrontal stimulation

- Increase (anodal) or decrease (cathodal) of α and θ rhythm (EEG)
- Improvement of DMN connectivity (MRI) in healthy subjects



Zaehle et al., BMC Neurosci, 2011

Perspective

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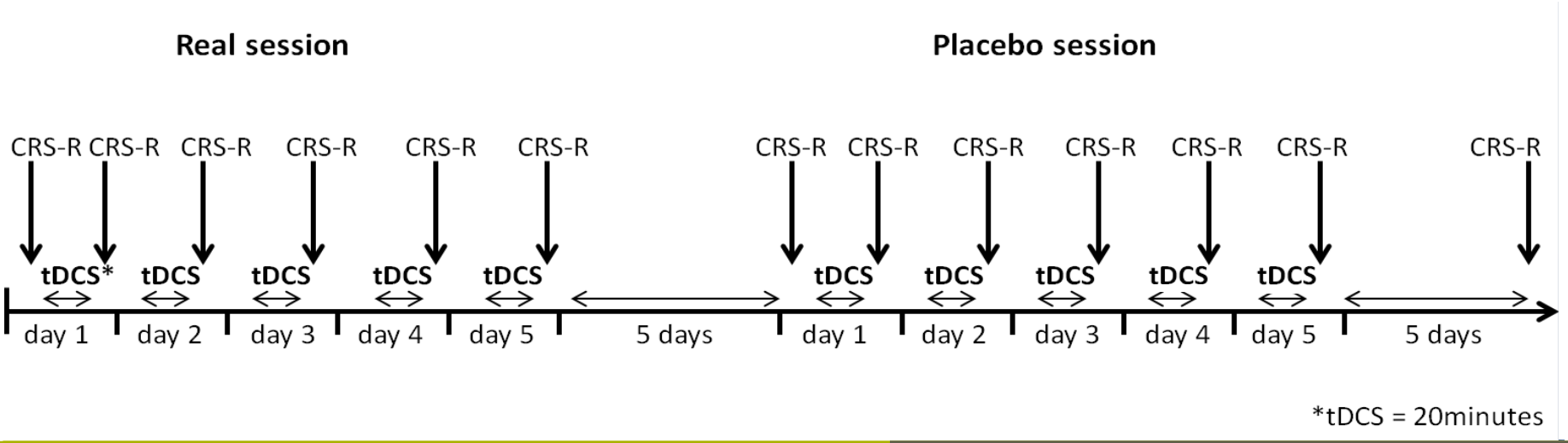
tDCS – long term

Effects last 90 minutes (Hummel et al., Lancet 2006)

- Short improvement
- Back to initial state

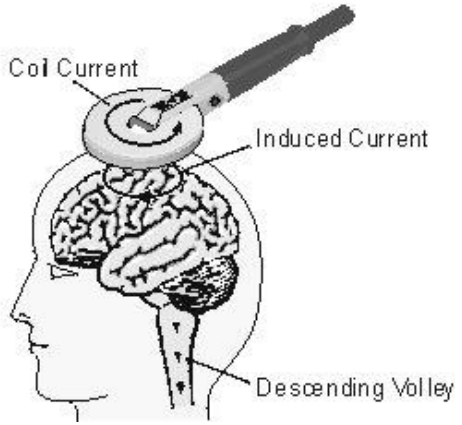
Daily stimulations (5days) (Antal et al., J Pain Symptom Manage 2010)
improvement and extension of benefits



tDCS - M1

Cognitive effects ⊕

Motor effects ?



Parameters:

2 mA – 20 min

Anode: M1

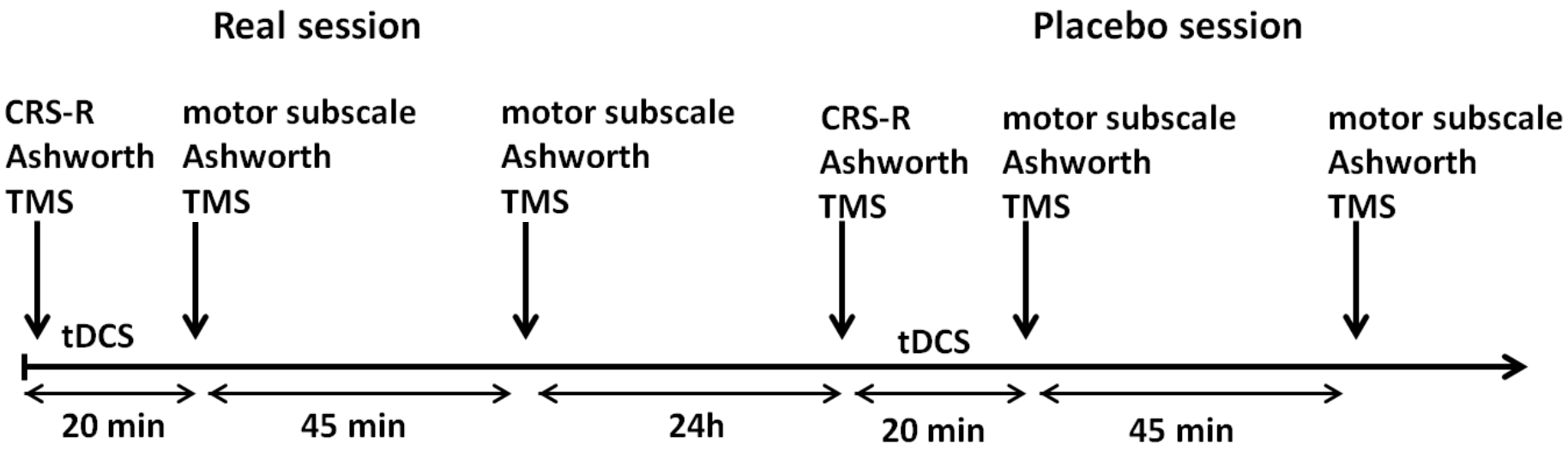
Cathode: supraorbicular controlateral cortex

1. **TMS**: MEP & motor threshold

2. **Behavioral** assessments: CRS-R & Ashworth

Lang et al., 2004

tDCS – M1



Cognition and motricity are indissociable for functional rehabilitation

tDCS – neurophysiology

1. Comparison of the results with:

- cortical lesions (MRI)
- cerebral metabolism (PET-scan)

⇨ Stimulation of preserved or damaged cortex?

2. EEG before and after tDCS

⇨ Better understanding of neurophysiological effects of tDCS

Conclusion

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Conclusion

⇨ **tDCS** improves **cognition** in both acute and chronic; TBI and non-TBI minimally conscious state patients

Future studies:
1. long term tDCS
2. tDCS on M1
3. neurophysiological effects

THANK YOU

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James S. McDonnell Foundation

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BCI and Detection of Consciousness

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