

# How, When and What-ifs of Transcranial Direct Current Stimulation for Tinnitus

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# Transcranial direct current stimulation (TDCS)

- Weak current can be used to polarise cortex
- Anode: depolarisation
  - Neurons are more likely to fire
- Cathode: hyperpolarisation
  - Neurons are less likely to fire



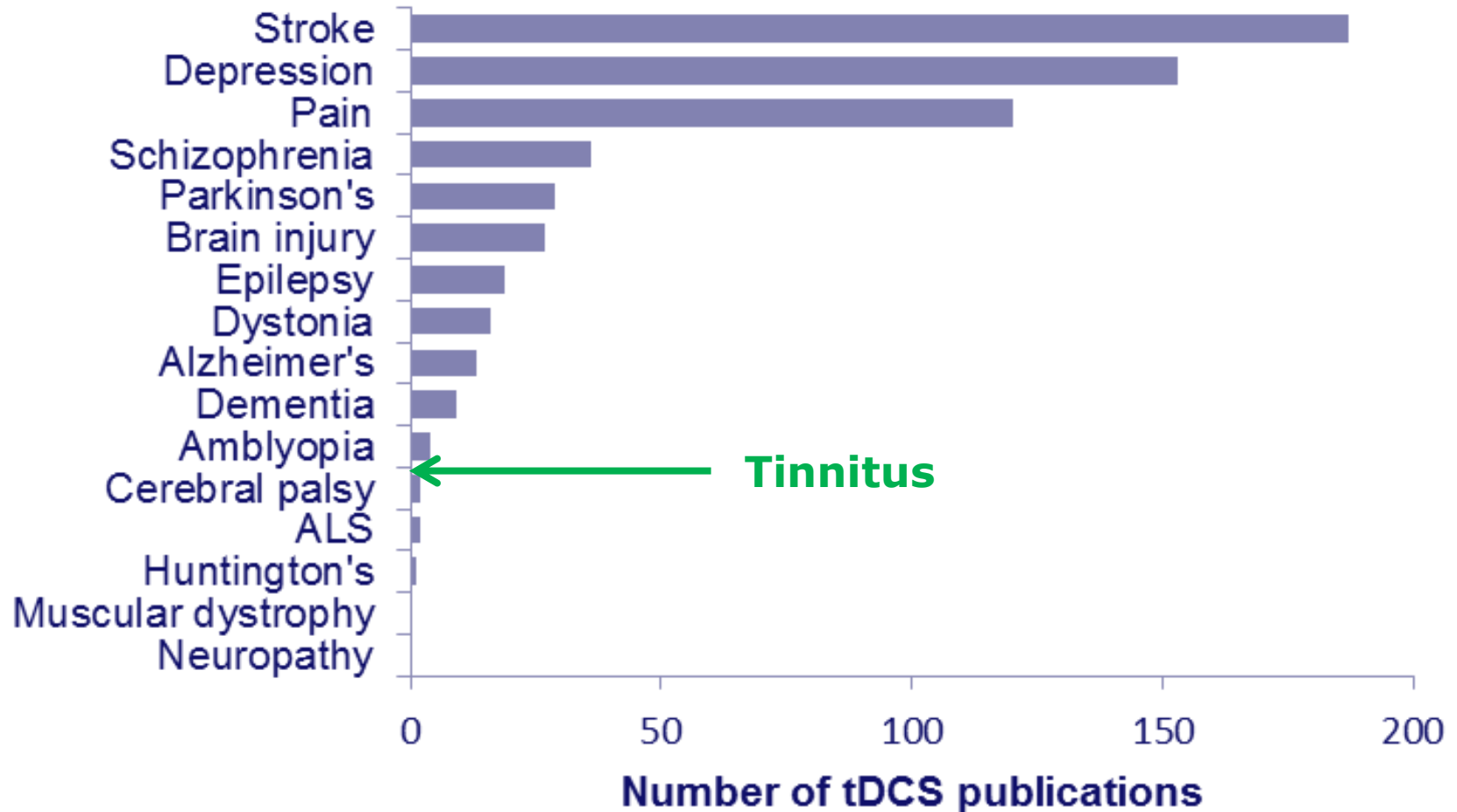
# Is this safe?

- Neurologist screens for contraindications
- Potential adverse effects
  - Skin burns
- Common experiences
  - Mild itching or prickling skin sensation

# TDCS

- Typical intensity: 1 – 2 mA
- Typical duration: 10 – 20 minutes
- Advantages over rTMS
  - Fewer contraindications
  - Portable
  - Simple
  - Inexpensive

# Neurology applications

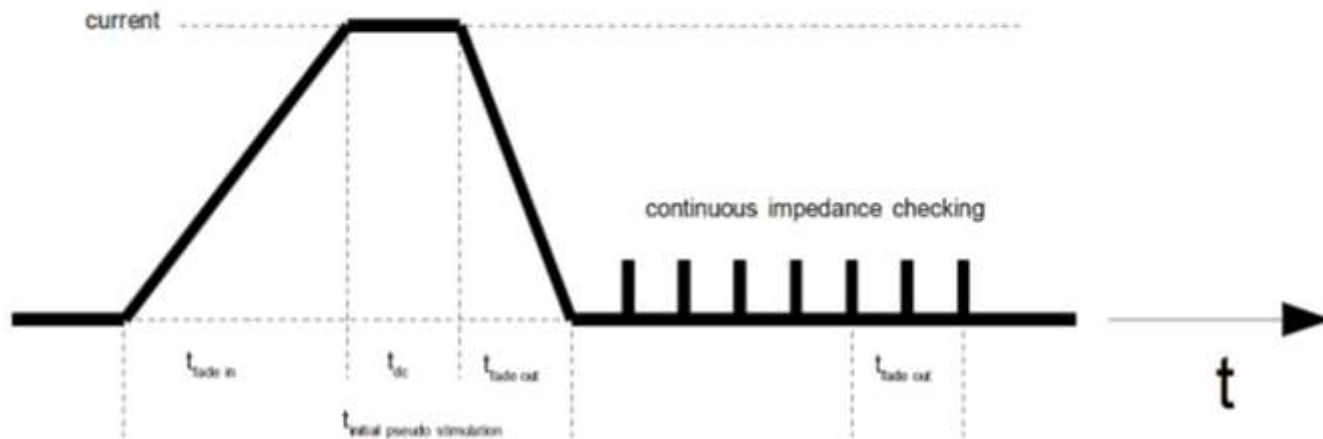
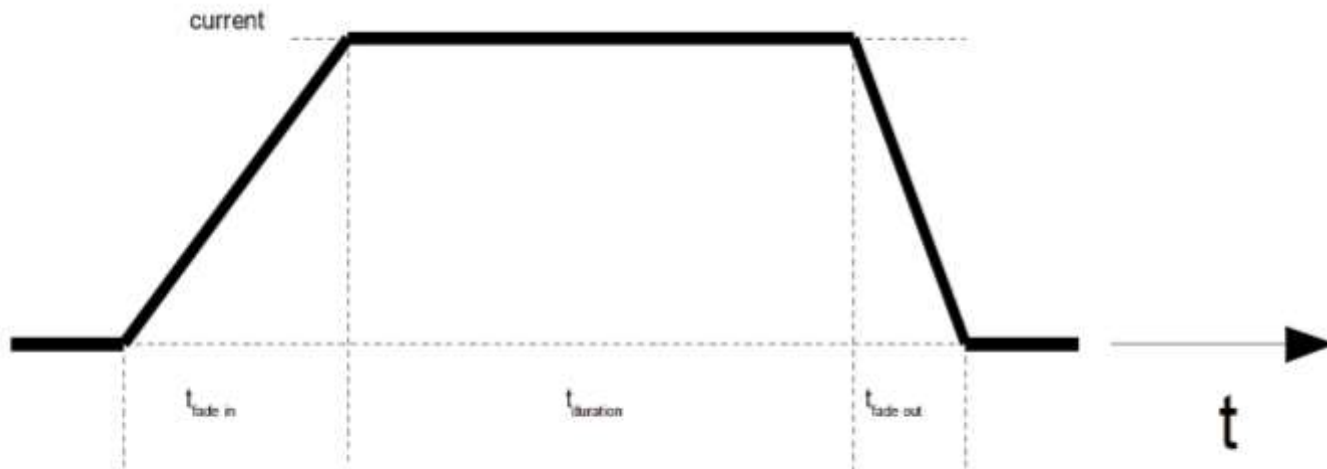


# Contents

- What we know ?
- What we don't know ?
- What should be done ?

**Q1. What do we know ?**

# Real Vs. Sham tDCS





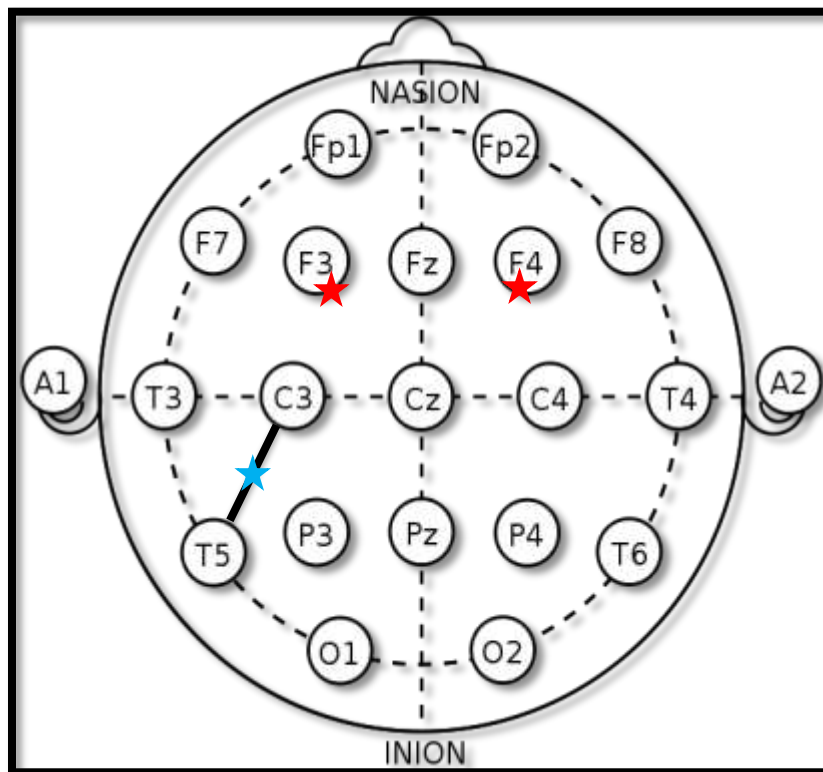
# Publications

| Studies              | Location        | Intensity     | Duration           |
|----------------------|-----------------|---------------|--------------------|
| Fregni et al 2006    | LTA             | 1 mA          | 3 Minutes          |
| Vanneste et al 2010  | DLPFC           | 1.5 mA        | 20 Minutes         |
| Garin et al 2011     | LTA             | 1 mA          | 20 Minutes         |
| Vanneste et al 2011  | DLPFC           | 1.5 mA        | 20 Minutes         |
| Vanneste & DDR 2011  | DLPFC           | 1.5 mA        | 20 Minutes         |
| Frank et al 2012     | DLPFC           | 1.5 mA        | 30 Minutes         |
| Shekhawat et al 2012 | LTA             | 1 mA and 2 mA | 10, 15, 20 Minutes |
| Faber et al 2012     | DLPFC           | 1.5 mA        | 20 Minutes         |
| Shekhawat et al 2013 | LTA             | 2 mA          | 20 Minutes         |
| Vanneste et al 2013  | DLPFC           | 2 mA          | 20 Minutes         |
| Vanneste et al 2013  | Auditory cortex | 1.5 mA        | 20 Minutes         |

# Parameters

- Polarity – Anodal
- Intensity of Stimulation – 1 to 2 mA
- Duration of Stimulation – 10 to 20 Minutes
- Site of Stimulation – LTA/DLPFC

# LTA & DLPFC Location



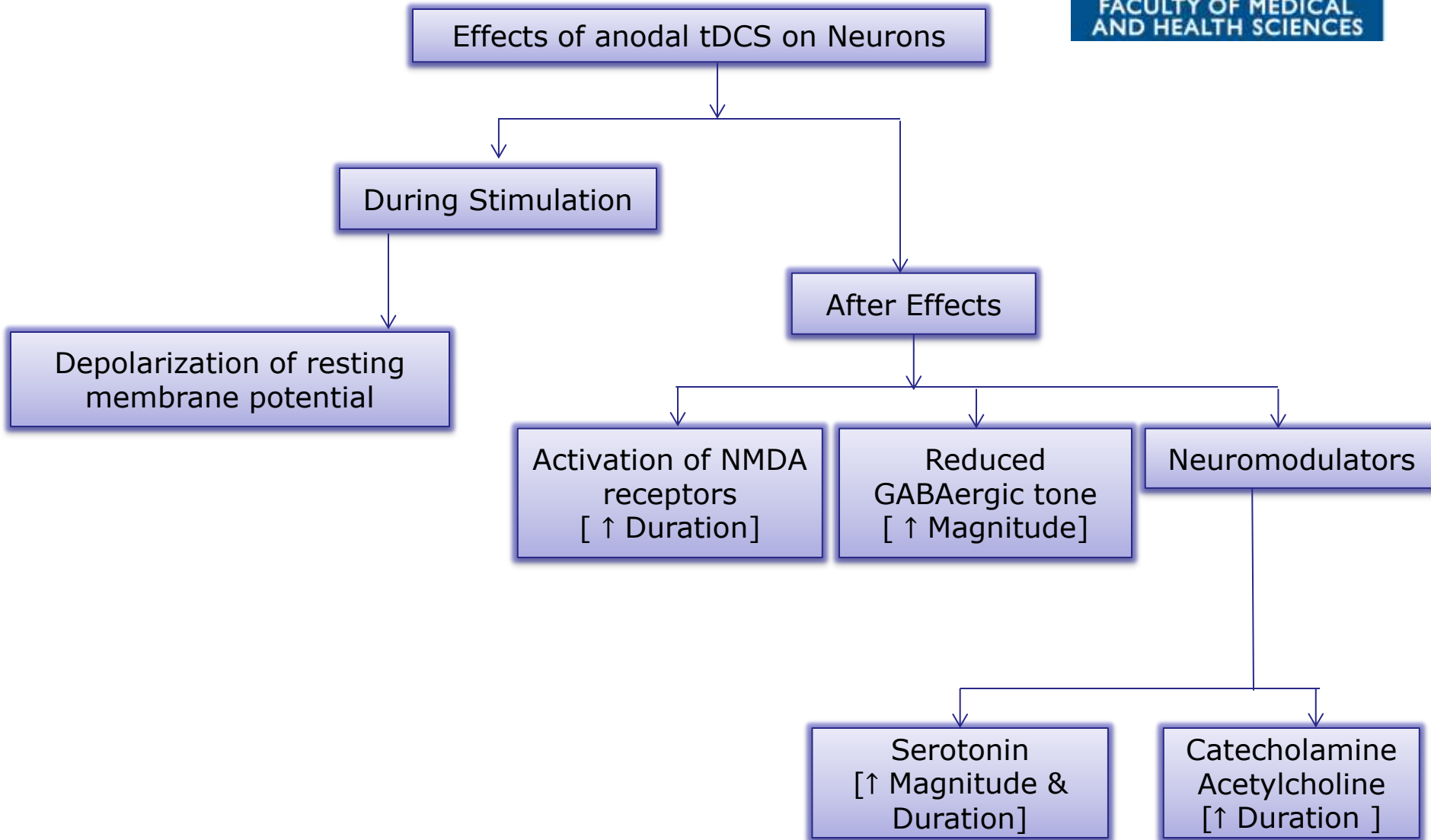
Nasion – point between the forehead and nose, at the junction of the nasal bones

Inion – most prominent point of the occipital bone

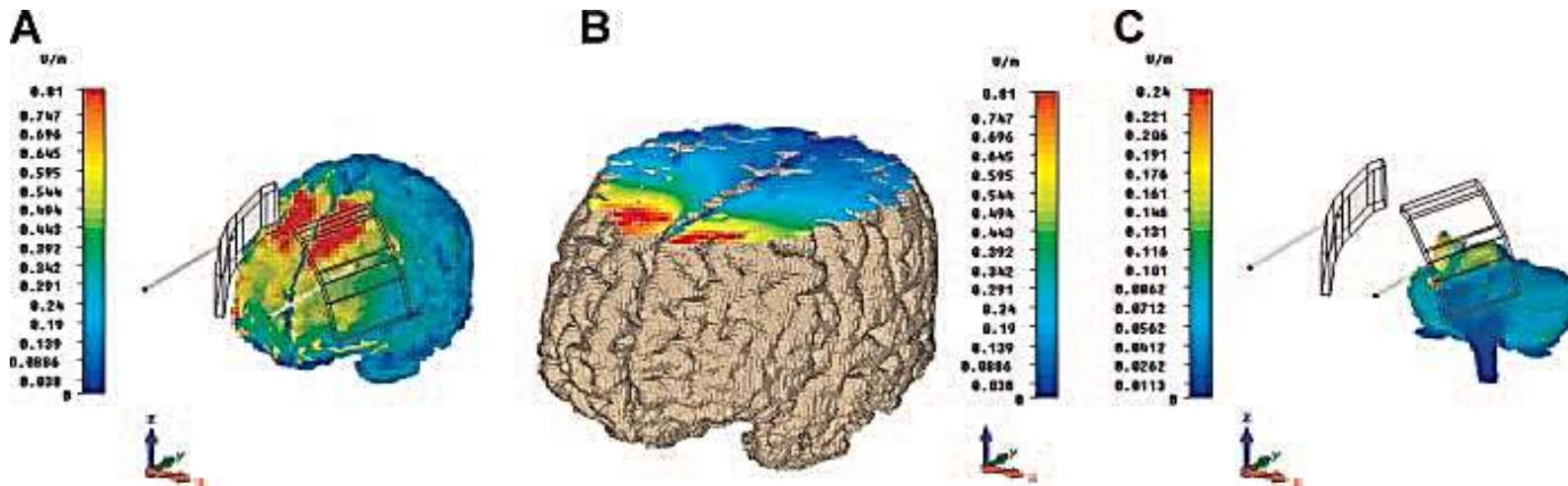
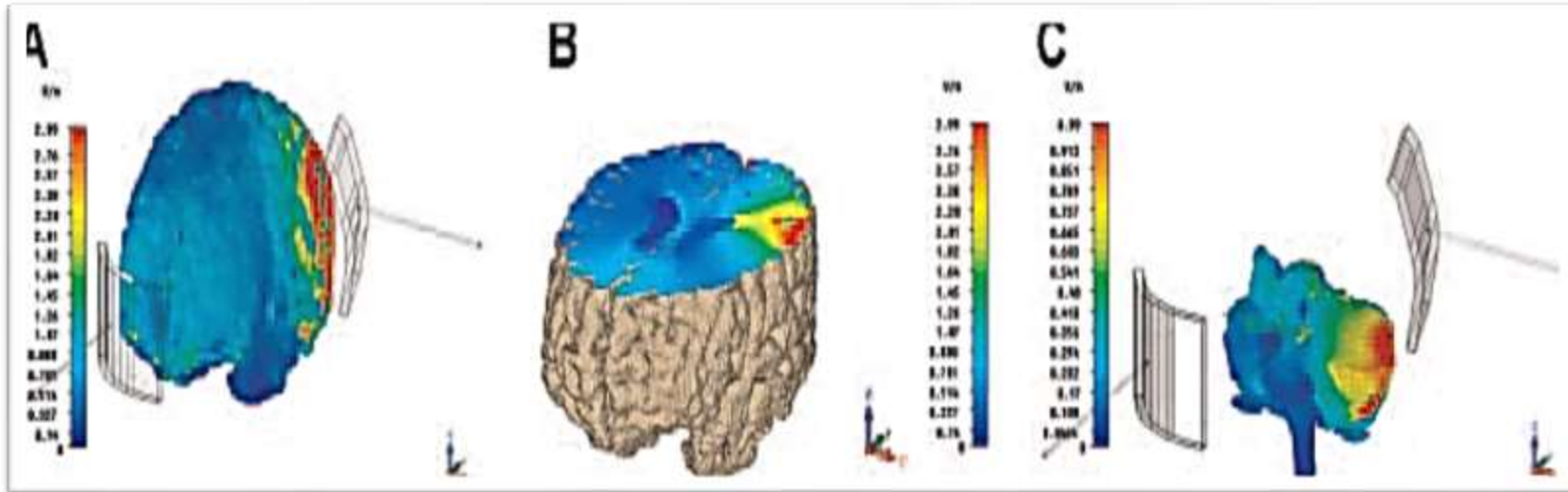
LTA – Halfway between C3 and T5

DLPFC – F3 and F4

# Physiological basis of anodal tDCS



# LTA Vs. DLPFC



**Q2. What we don't know ?**

# localization of currents

- Current Flow (Skull, CSF, Subcutaneous fat, Gyri and Sulci)
- Current Orientation (Tangential vs. Radial)

# Effect of tDCS on Tinnitus

- No mechanistic explanation

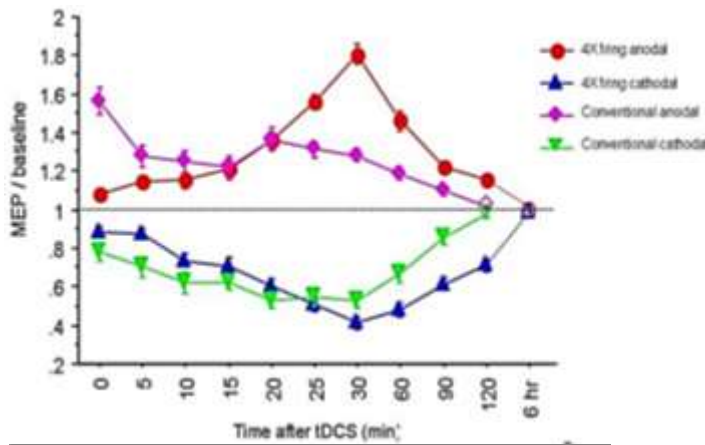
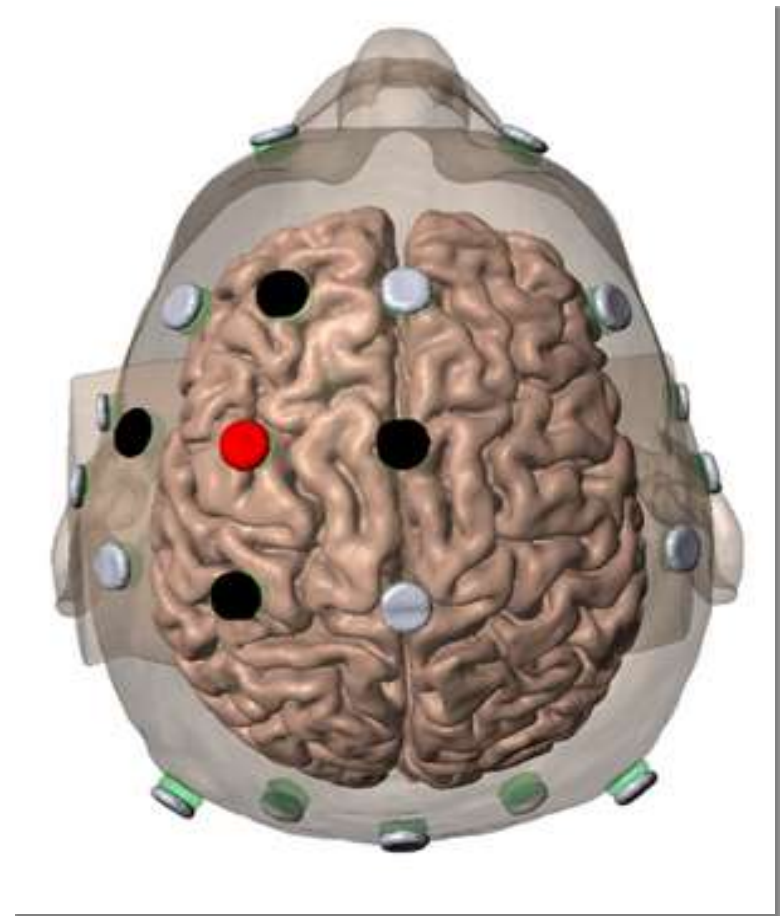


**Q3. What should be done ?**

# Electrophysiological measures

- Computational Neurostimulation models
- Rating scales (11) > Questionnaires (3)
- fMRI / EEG

# Improve Focality (HD-tDCS)



# Different protocols

- Combination of tDCS with others forms of intervention
- Multiple sites of Stimulation

# Responders Vs. Nonresponders

- Hearing loss
- Functional connectivity and resting state
- Genetic biomarkers

# Conclusion

- Past – Present – Future
- Potential tool for intervention

# Suppliers

- NeuroConn, Germany  
<http://www.neuroconn.de/profile/>
- Soletrix medical, USA  
<http://soterixmedical.com/tdcs>
- Magstim, UK  
<http://www.magstim.com/index>
- Inomed, Germany  
<http://www.inomed.com/>
- Trademe/Online/Home made ?

# Thank You