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# tDCS safety and Guidelines

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Introduction to Transcranial Electric Stimulation (tES) in  
Neuropsychiatric Research

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# Is tDCS Safe?

YES!

When applied in accordance with [safety guidelines](#) and reviews



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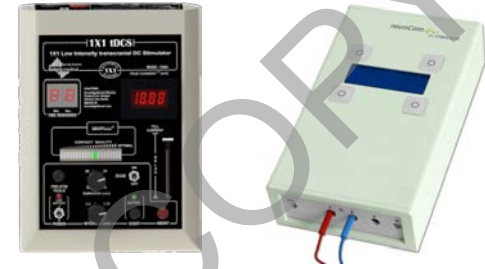
## Guidelines

### Low intensity transcranial electric stimulation: Safety, ethical, legal regulatory and application guidelines

A. Antal<sup>a,\*</sup>, I. Alekseichuk<sup>a</sup>, M. Bikson<sup>b</sup>, J. Brockmüller<sup>c</sup>, A.R. Brunoni<sup>d</sup>, R. Chen<sup>e</sup>, L.G. Cohen<sup>f</sup>, G. Dowthwaite<sup>g</sup>, J. Ellrich<sup>h,i,j</sup>, A. Flöel<sup>k</sup>, F. Fregni<sup>l</sup>, M.S. George<sup>m</sup>, R. Hamilton<sup>n</sup>, J. Haueisen<sup>o</sup>, C.S. Herrmann<sup>p</sup>, F.C. Hummel<sup>q,r</sup>, J.P. Lefaucheur<sup>s</sup>, D. Liebetanz<sup>a</sup>, C.K. Loo<sup>t</sup>, C.D. McCaig<sup>u</sup>, C. Miniussi<sup>v,w</sup>, P.C. Miranda<sup>x</sup>, V. Moliadze<sup>y</sup>, M.A. Nitsche<sup>z,aa</sup>, R. Nowak<sup>ab</sup>, F. Padberg<sup>ac</sup>, A. Pascual-Leone<sup>ad</sup>, W. Poppendieck<sup>ae</sup>, A. Priori<sup>af</sup>, S. Rossi<sup>ag</sup>, P.M. Rossini<sup>ah</sup>, J. Rothwell<sup>ai</sup>, M.A. Rueger<sup>aj</sup>, G. Ruffini<sup>ab</sup>, K. Schellhorn<sup>ak</sup>, H.R. Siebner<sup>al,am</sup>, Y. Ugawa<sup>an,ao</sup>, A. Wexler<sup>ap</sup>, U. Ziemann<sup>aq</sup>, M. Hallett<sup>ar,1</sup>, W. Paulus<sup>a,1</sup>

<http://www.ifcn.info/>

tDCS device



Cables and sponges



Montage and  
Safe parameters



# tDCS device

- Automatic Current Ramping
- Current Fluctuation During Stimulation
  - Display of Actual Current
- Impedance Check / beep and stop
- Current Spiking During Device On/Off



# Cables and sponges

Always use Saline.

Possible alternatives:

- Electrode gel or cream



Tap water is **not** recommended



# Cables and sponges

- Broken cables
- Rust and corrosion
- Old/Dried out sponges
- Moisture of sponges  
Be careful, no dripping!



# Montage and Safe parameters

Electrodes should make **uniform** contact with the scalp



Current intensity: 1 – 2 mA (< 4 mA)

Duration: 10 – 20 min/day (up to 60 min/day)

Electrode area: 25 – 35 cm<sup>2</sup> (1 to 100cm<sup>2</sup>)

**Abrading** the skin before placing the electrode is **not recommended**  
(Loo et al. 2011)

# Safety limits and animal studies

Current intensity

Duration

Electrode area



*Liebetanz et al, 2009*

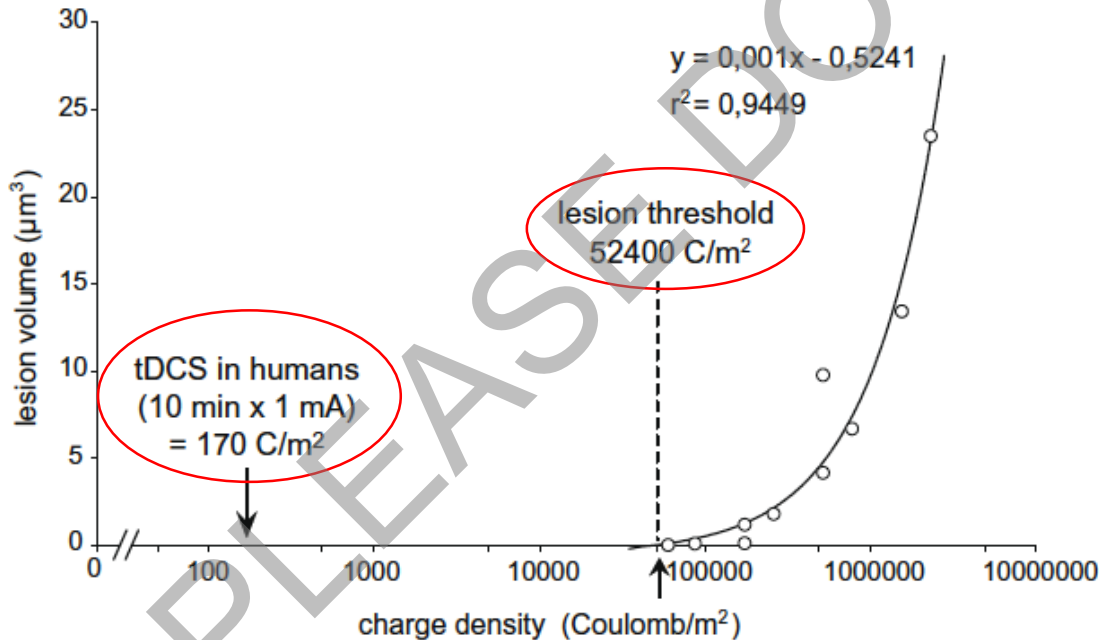


# Safety limits and animal studies

Current intensity

Duration

Electrode area



*Liebetanz et al, 2009*

# Is tDCS Safe?

YES!

When applied in accordance with [safety guidelines](#) and reviews

BUT...

Mild and moderate Adverse Events (AEs) may happen

## **A systematic review on reporting and assessment of adverse effects associated with transcranial direct current stimulation**

Andre Russowsky Brunoni<sup>1,2,3</sup>, Joao Amadera<sup>1</sup>, Bruna Berbel<sup>1</sup>, Magdalena Sarah Volz<sup>1</sup>, Brenno Gomes Rizzerio<sup>1</sup> and Felipe Fregni<sup>1,2</sup>

- Systematic review of reported adverse events (AEs) in patients and healthy subjects:
  - 172 articles (209 studies) included
  - 117 studies assessed AEs
  - 74 studies reported at least 1 AE

# **A systematic review on reporting and assessment of adverse effects associated with transcranial direct current stimulation**

Andre Russowsky Brunoni<sup>1,2,3</sup>, Joao Amadera<sup>1</sup>, Bruna Berbel<sup>1</sup>, Magdalena Sarah Volz<sup>1</sup>, Brenno Gomes Rizzerio<sup>1</sup> and Felipe Fregni<sup>1,2</sup>

**Mild AEs** are the most commonly reported

- **Itching (39.3%)**
- Tingling (22.2%)
- Headache (14.8%)
- Discomfort (10.4%)
- Burning sensation (8.7%)

# Skin redness and burn



*Wang et al. 2015*

Healthy subject

Single session

2 mA, 26 min, 35 cm<sup>2</sup>

The sponges were too old

Skin abrading prior to tDCS

Uneven current distribution

# Skin burn



*Palm et al. 2008*

→ 10 Patients, multiple sessions

1 mA, 20 min, 35 cm<sup>2</sup>

Skin redness

→ 5 Patients, multiple sessions

2 mA, 20 min, 35 cm<sup>2</sup>

Skin burns

Tap water instead of Saline

# Contact dermatitis



*Riedel et al. 2008*

Healthy subject

Single session

0.75 mA

20 min

Anode 100 cm<sup>2</sup>

Cathode 9cm<sup>2</sup>

Skin irritation and pruritus

2 days after the stimulation

Probable allergic reaction



# Additional considerations

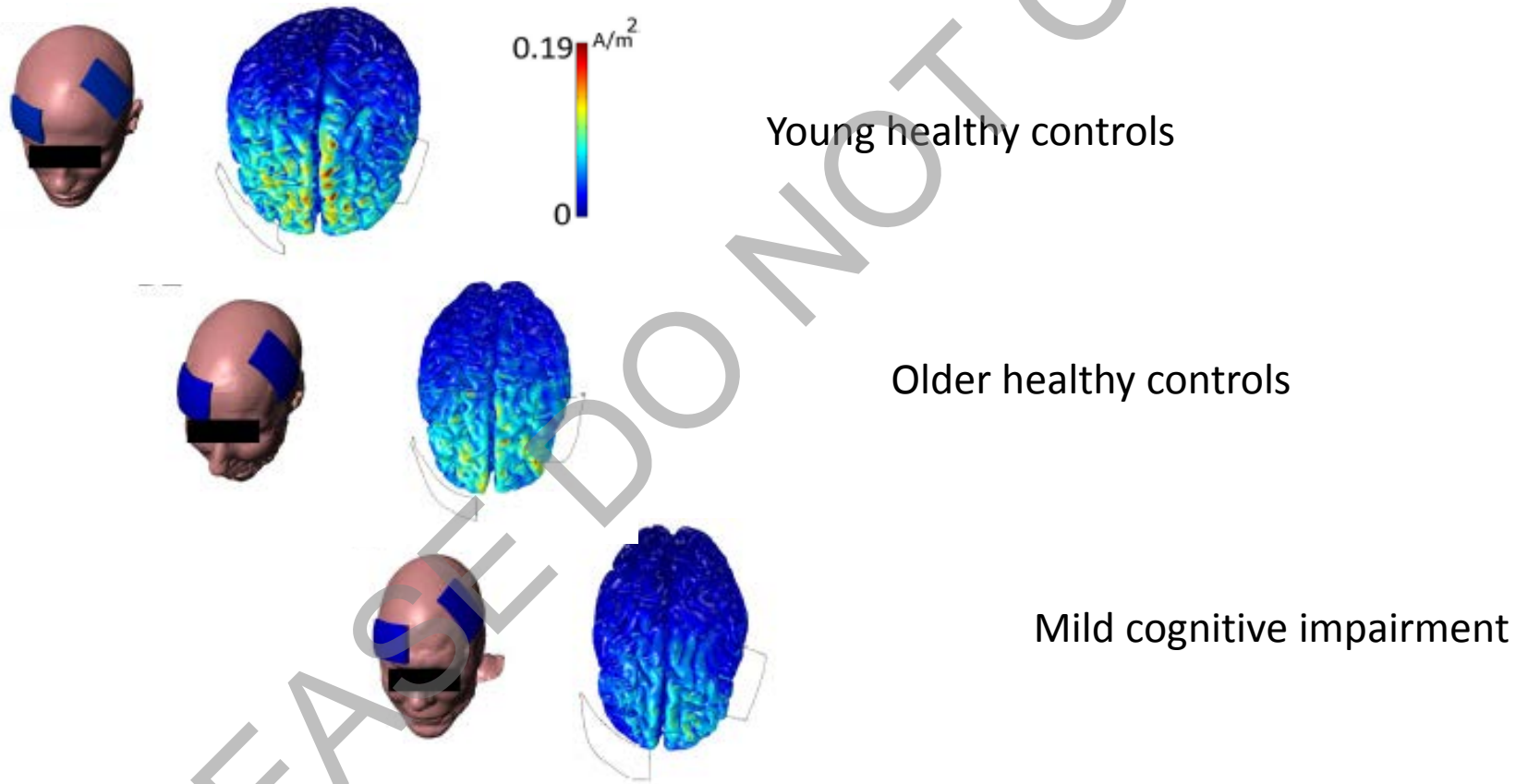
- Screening questionnaire:
  - Metal or electronic implants in the brain/skull or elsewhere
  - Brain or spinal cord surgery
  - Head trauma with impairment of consciousness
  - Skin problems (dermatitis, eczema...)
  - History of epilepsy
  - Pregnancy
  - Medications



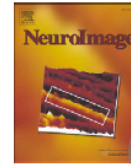
# Additional considerations

- Safety in children
  - Reported AEs are the same as in adults
  - Thinner skulls, thus less resistance and greater amount of current
- Safety during pregnancy
  - Research: Questionnaires should ask about pregnancy
  - Clinical practice: Only when benefit is higher than risk
- Safety in older age
  - Reported AEs are the same as in young adults
  - Cortical atrophy in age-related diseases

# tDCS modeling in the brain



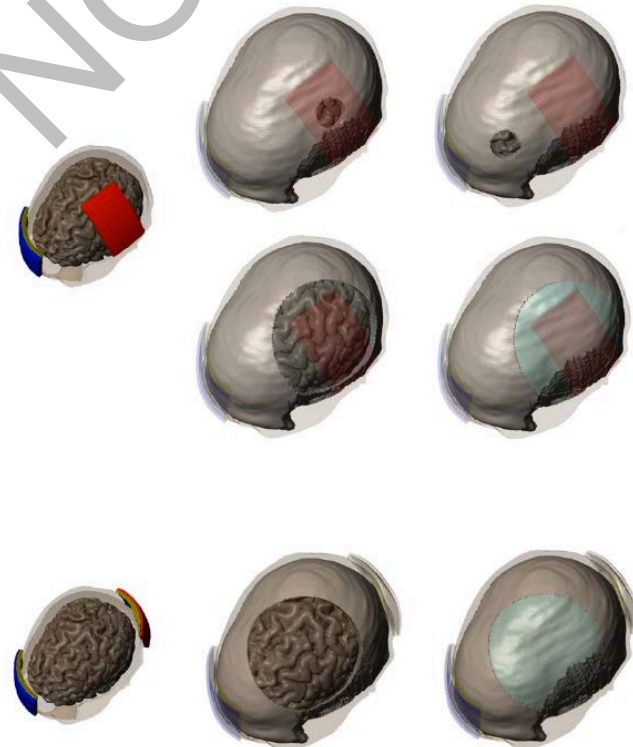
*Mahdavi et al., 2017*

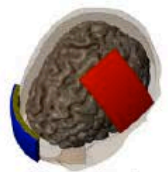


Transcranial direct current stimulation in patients with skull defects and skull plates:  
High-resolution computational FEM study of factors altering cortical current flow

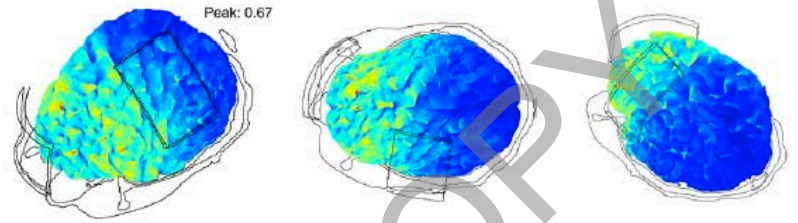
Abhishek Datta <sup>a,\*</sup>, Marom Bikson <sup>a</sup>, Felipe Fregni <sup>b,c,\*</sup>

# Skull defect



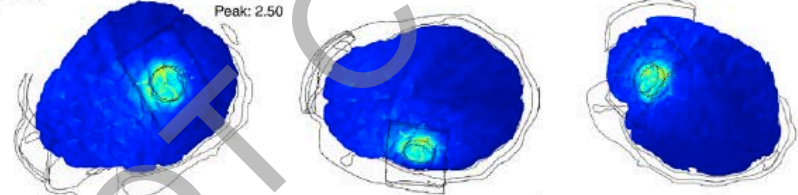


Conventional motor cortex IDCS

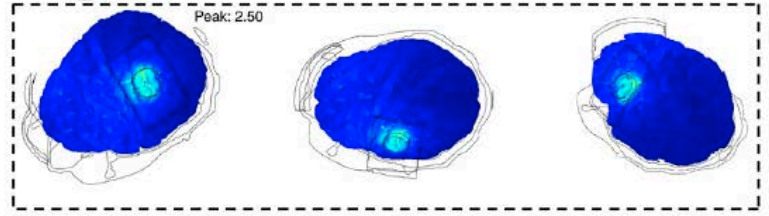
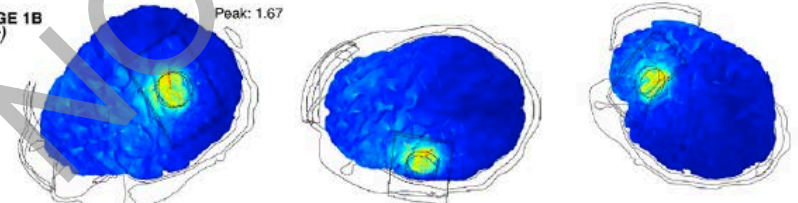


Montage 1

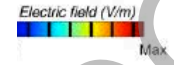
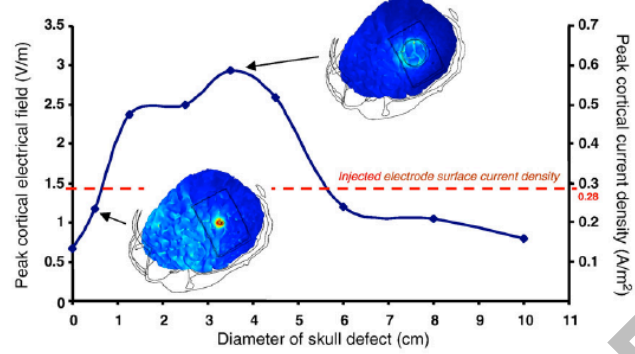
MONTAGE 1A (acute)



MONTAGE 1B (chronic)

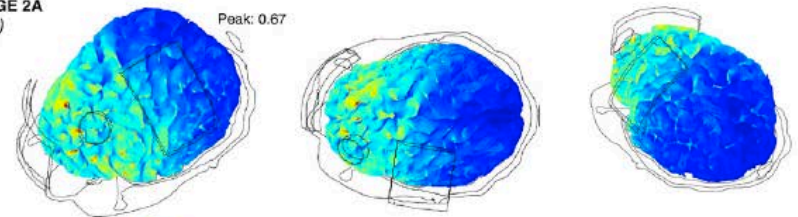


A. 7 x 5 cm<sup>2</sup> pads

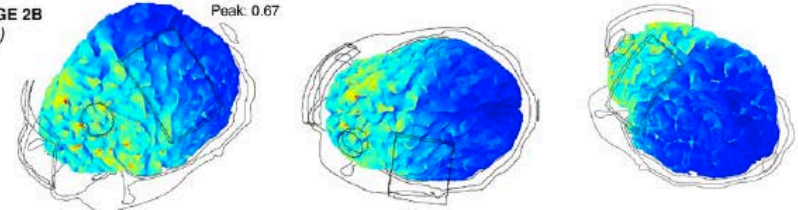


Montage 2

MONTAGE 2A (acute)



MONTAGE 2B (chronic)



Datta, 2010

PLEASE DO NOT COPY

# Safety Recommendations

- Always screen for **exclusion criteria and AEs**
- Follow guidelines recommendations
- Verify **safety montage** and setup **parameters**
- Consider environment (ex. Hospital/University) and plan **emergency procedures** accordingly
- Keep informed of new **safety guidelines**