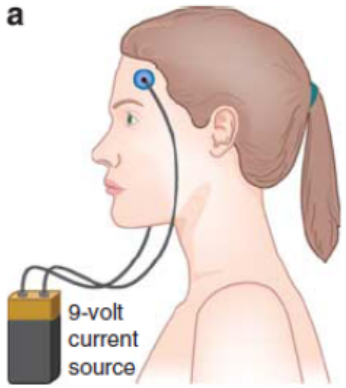
Neurophysiological impact of a fronto-temporal transcranial direct current stimulation (tDCS) in healthy subjects: a multimodal imaging approach

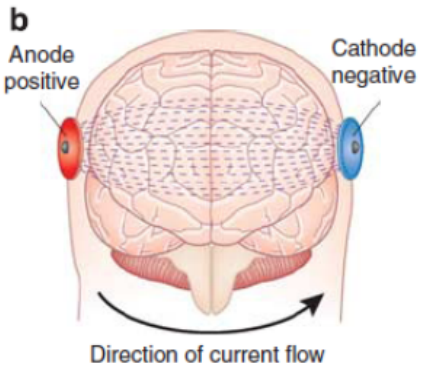
Team: Psychiatric disorders: from Resistance to Response (ΨR2)

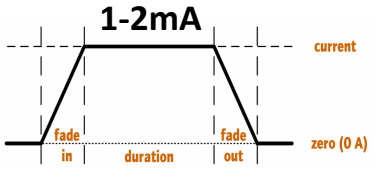
Clara FONTENEAU

NEUROSTIMULATIONS

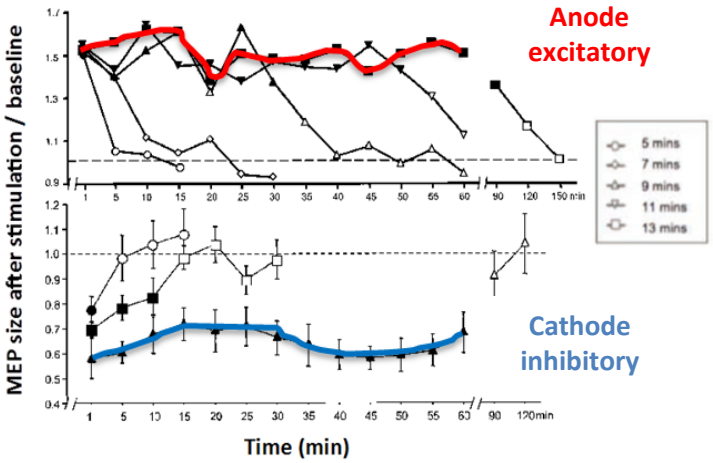
transcranial Direct Current Stimulation
tDCS







Primary Motor Cortex Stimulation



Nitsche et al., Neurology, 2001
Nitsche et al., Clin Neurophysiol, 2003b

➢ Modulation of **cortical excitability**

Frontal Neurostimulations

DLPFC  An effect in **local** and in **connected regions**

1- Brain activity (ASL)

Antal et al., Human Brain Mapping, 2014
Stagg et al., J Neurosci, 2013

2- Functional connectivity in and between networks, like resting state networks (fMRI)

Keeser et al, Journal of Neuroscience, 2011
Saoite et al, Front Hum Neurosci, 2013
Mondino et al, Schiz Bull, 2015

3- Structural connectivity (DTI)

Peng et al., J Affective Disorders, 2012

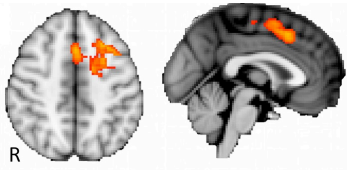
4- Subcortical dopaminergic transmission (PET)

Strafella et al., Brain, 2003; Pogarell, J Psy Res, 2006
Cho&Strafella, PLoS One, 2009; Brunelin et al., Schizophr Res, 2011

EXAMPLES

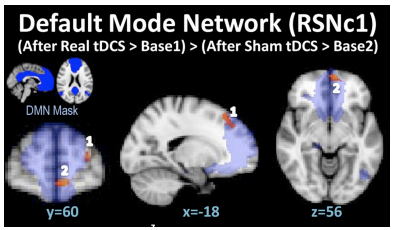
Healthy sujects

Anode vs Cathode

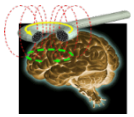


Stagg et al., J Neurosci, 2013

Healthy sujects

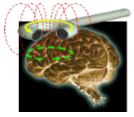


Keeser et al, J Neurosci, 2011



Patients with depression

Modification of anisotropic fraction after rTMS

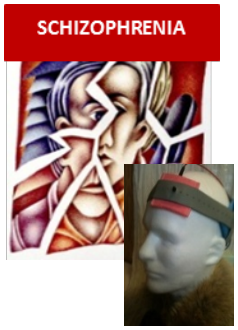


Healthy sujects

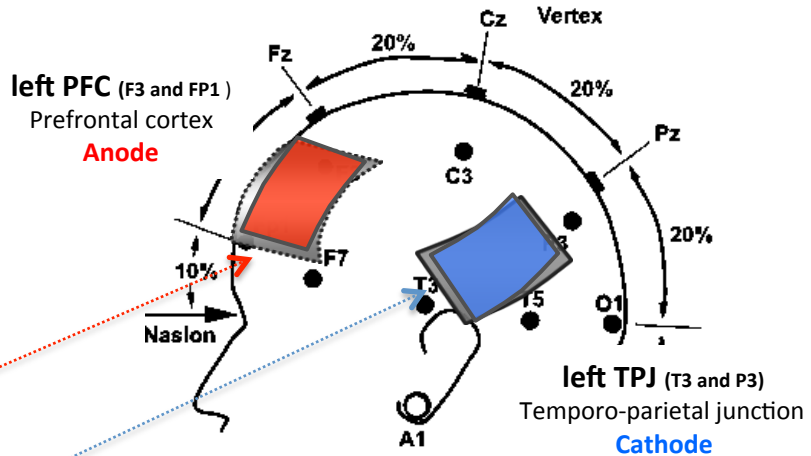
Subcortical Dopamine ↗

Temporal and functional organisation ?

PSYCHIATRY



SCHIZOPHRENIA



Pathophysiology

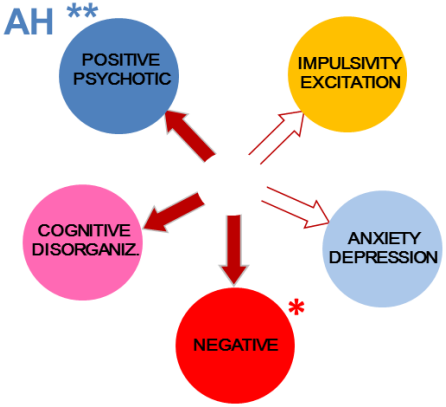
- Hypoactivity of the left prefrontal cortex
  Lawrie et al, Biol Psychiatry, 2002
  Sanfilipo et al, Arch Gen Psychiatry, 2000
- Hyperactivity of the left temporo-parietal cortex
  Sibersweig et al., Nature, 1995
- Dopaminergic alterations
  Brunelin et al, Curr Med Chem, 2013

THERAPEUTIC EFFECTS

SCH *

Brunelin et al., Am J Psychiatry. 2012
Koops et al., Front Psychol, 2015

AH **



Neurophysiological correlates ?

PROJECT

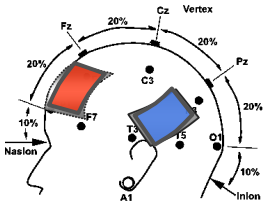
Temporal and functional organisation of the neurophysiological correlates of fronto-temporal tDCS ?

*Creating a **coherent ensemble** of the effects of the stimulation combining:*

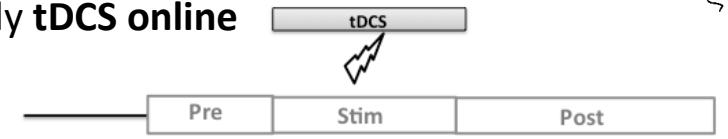
1) Structural and functional connectivity
2) Brain activity
3) Subcortical dopaminergic transmission

- Use of a **multimodal imaging system**
  - ✓ Simultaneous imaging MRI & PET (MRI-PET Hybrid machine)
  - ✓ Link between connectivity, brain activity and subcortical dopaminergic transmission

- Adopt the **fronto-temporal montage**



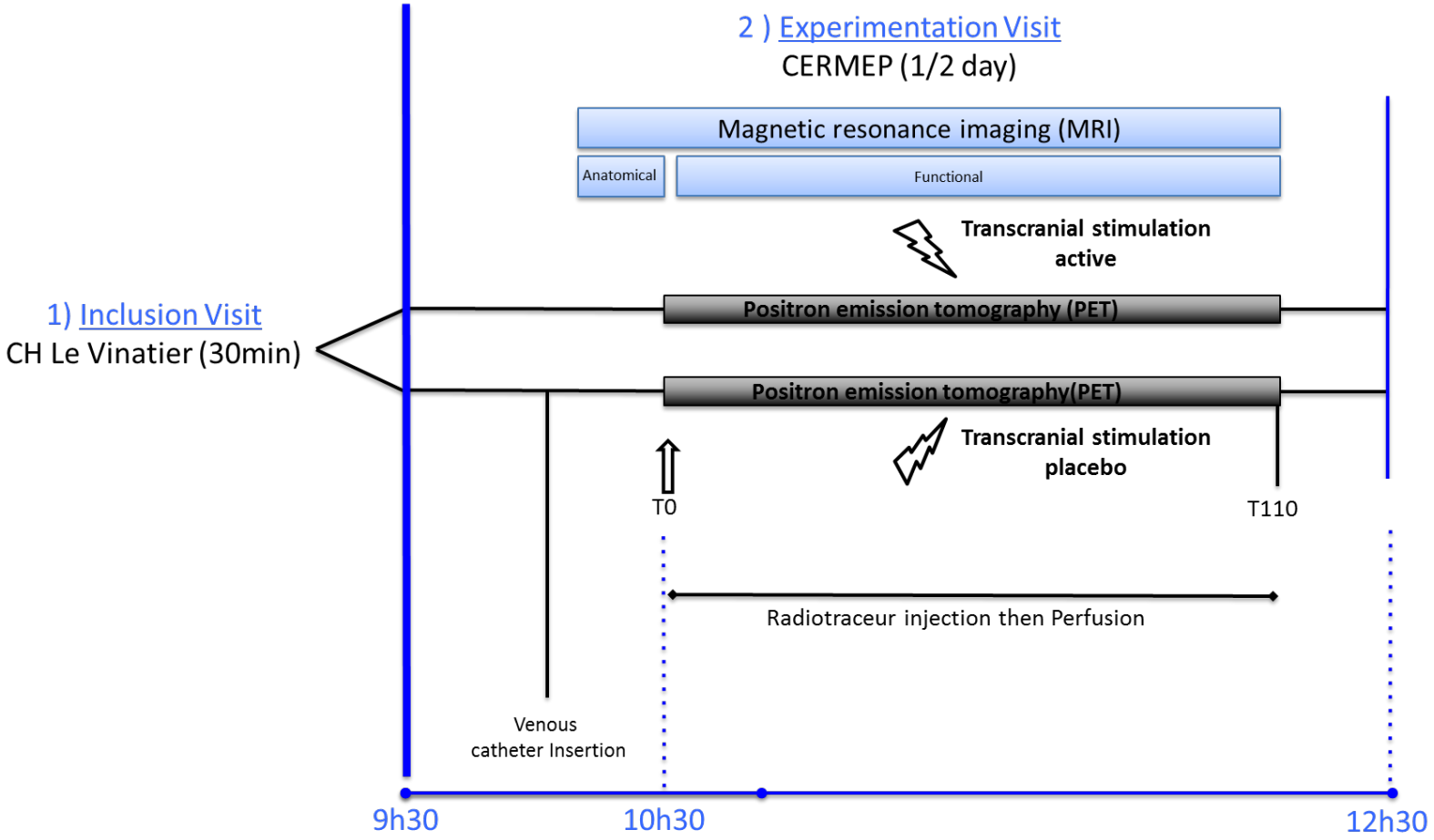
- Apply **tDCS online**



- First step in **healthy subjects**

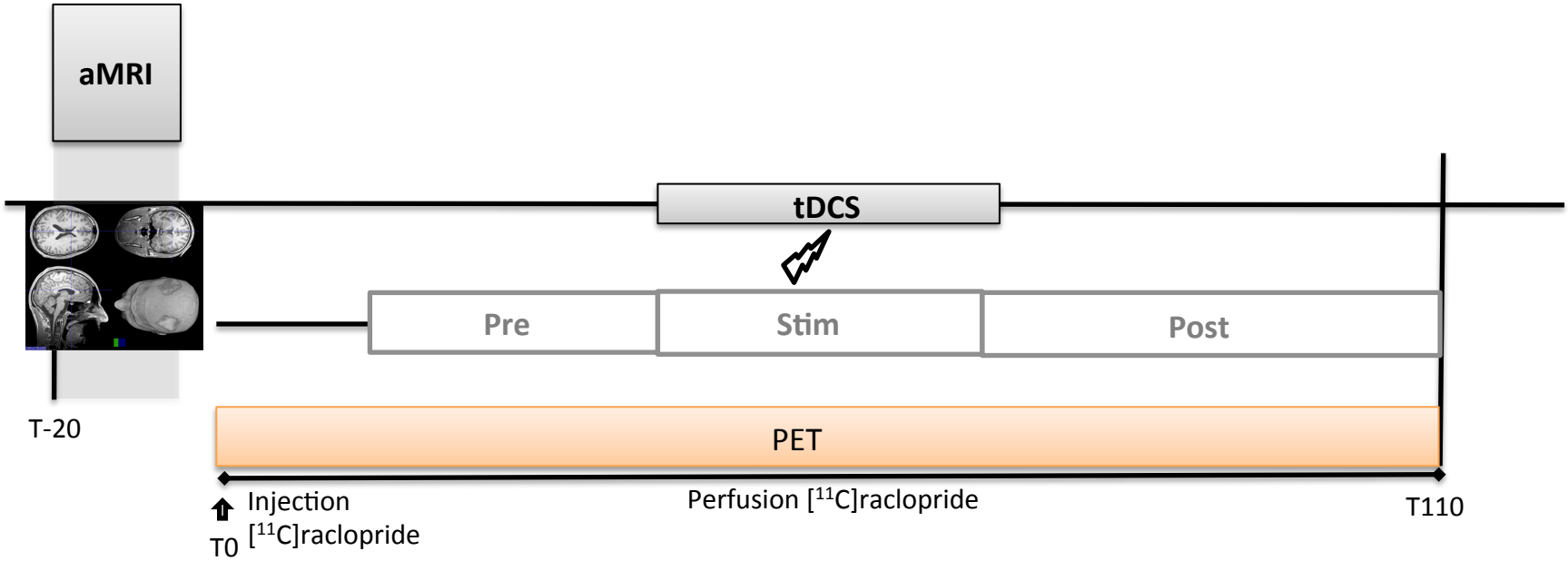
PROJECT

➢ Randomized, double blind study, 2-arm parallel groups in healthy subjects



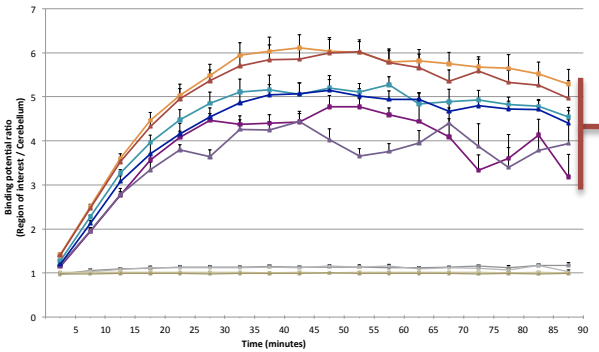
	ACTIVE	PLACEBO
n	15	15

Neurophysiological impact of a fronto-temporal transcranial direct current stimulation in healthy subjects

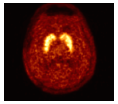


PET – Raclopride:

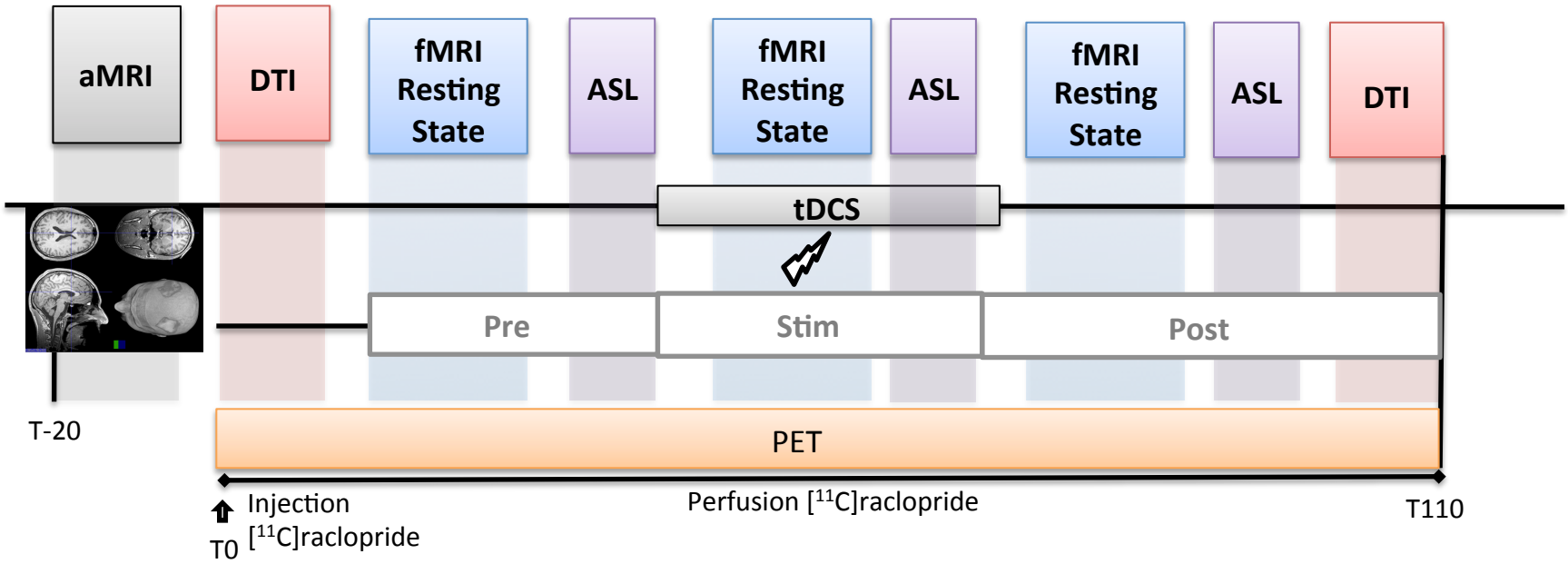
Dopaminergic transmission in basal ganglia
→ **Static** and **Dynamic** approach



3 subcortical dopaminergic regions



Neurophysiological impact of a fronto-temporal transcranial direct current stimulation in healthy subjects



MRI – Sequences:

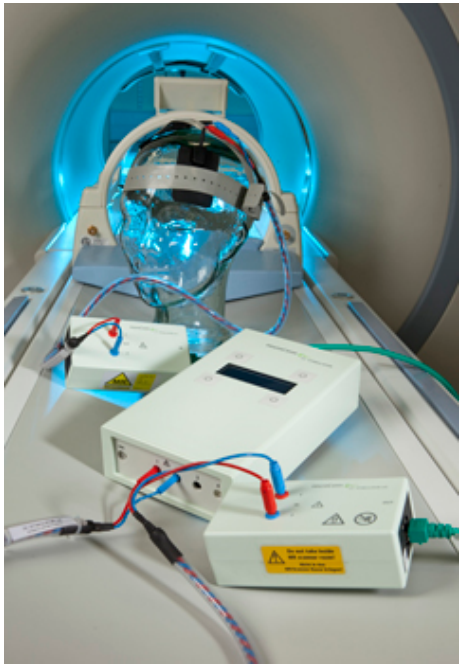
Resting state fMRI – functional connectivity

ASL – Brain activity

DTI – Structural connectivity

→ Region of interest analysis
- stimulated regions: **DLPFC** & **TPJ**
- connected regions: **Resting state networks**

Feasability



Stimulator used in international publications

Antal, et al., NeuroImage, 2011
Sehm et al., Front Hum Neurosci, 2013
Stagg et al., J Neurosci, 2013
Antal et al., NeuroImage, 2014
Meinzer et al., Journal of visualized experience, 2014

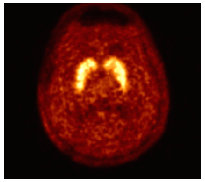
- **Ethics & Radiotracer Autorisation (ANSM – CPP)**
- **Neurodis Funding**
- **tDCS online**

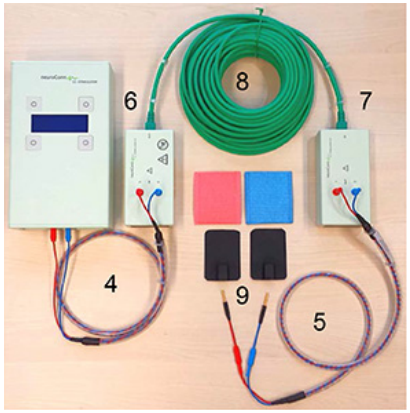
  MRI compatible, CE

  NeuroConn DC stimulator MR

First subjects

N=3





- Collaboration CERMEP

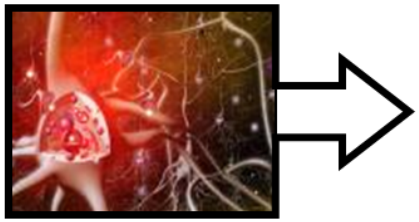
Project impact

MRI & PET

Coherent ensemble

Imaging biomarker

NEUROBIOLOGY



NEUROPHYSIOLOGY

Dopamine (TEP)

Resting state networks (IRMf)
Perfusion (ASL)
Structural connectivity (DTI)

« Normal brain »

Pathological brain

Neurophysiological effects of fronto-temporal tDCS

Improved psychiatric symptoms

Multiple applications

Original Article | April 1, 2013

The Sertraline vs Electrical Current Therapy for Treating Depression Clinical Study

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Oliveira,
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JAMA P

ELSEVIER

Contents lists available

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Drug and Alcohol Dependence

The World Journal of Biological Psychiatry, 2014; Early Online: 1–15

frontiers in
HUMAN NEUROSCIENCE

REVIEW ARTICLE
published: 14 August 2013
doi: 10.3389/fnhum.2013.00449

Non-invasive brain stimulation can induce paradoxical facilitation. Are these neuroenhancements transferable and meaningful to security services?

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ALVAO[1],