3-Applications aux déficits cognitifs

Négligence spatiale unilatérale

atteinte PPC droit

2 cibles potentielles pour NIBS:
- stimulation du PPC droit
- inhibition du PPC gauche
Recent human studies have demonstrated that anodal polarization of DC brain varies depending on the polarity of the cortical excitability. Transcranial direct current (DC) brain polarization significantly contributes to disability after stroke because it has a source of long-term disability after stroke, there are few efficacies in itself and has been found to be associated with poor visuospatial neglect of hemispace. This hemispatial neglect suggests that the parietal cortex in stroke patients with spatial neglect.

Effects of DC brain polarization on the line-bisection test (A), the shape-unstructured cancellation test (B), and the letter-structured cancellation test constructed by Mesulam (C). The effect of improving visual scanning after DC brain polarization of parietal cortex in stroke patients with spatial neglect was carried out using Tukey post hoc comparisons. The results are consistent with the findings of other studies. The interaction term intervention vs. time (pre and post) and assessed whether the effects of DC brain polarization on neglect symptom in stroke patients. Clinical trials of tDCS anodal 20 mn, 2mA en regard PPC droit / sham tDCS -48h d’intervalle entre les 2 sessions

-15 patients, 1 à 3 mois post AVC
cross over randomisé, contre placebo, double aveugle
tDCS anodal 20 mn, 2mA en regard PPC droit / sham tDCS
-48h d’intervalle entre les 2 sessions
test de bissection de lignes, 2 tests de barrage
Négligence spatiale unilatérale

stimulation ipsilésionnelle

Bidirectional alterations of interhemispheric parietal balance by non-invasive cortical stimulation

-20 sujets sains

tDCS anodale
tDCS cathodale
tDCS sham

pour PPC droit et gauche

10mn, 1mA

tâche de détection visuelle

-résultats:

modulation bidirectionnelle

tDCS anodale PPC Dt ou G vers espace contralatéral

tDCS cathodale PPC Dt ou G vers espace ipsilatéral

Sparing et al, 2009
Négligence spatiale unilatérale
stimulation ipsilésionnelle
Bidirectional alterations of interhemispheric parietal balance by non-invasive cortical stimulation

- 10 patients, 1 à 12 mois post AVC
  - tDCS anodale  PPC droit
  - tDCS cathodale  PPC gauche
  - tDCS sham

10mn, 1mA
tâche de détection visuelle

-résultats:
Négligence spatiale unilatérale
inhibition contralésionnelle

1 Hz repetitive transcranial magnetic stimulation of the unaffected hemisphere ameliorates contralesional visuospatial neglect in humans

-3 patients, <6 mois post AVC

rTMS 1 Hz
cortex pariétal G
7 sessions consécutives sur 2 semaines

-évaluation: Landmark (lignes prébisséquées), horloge, bissection lignes
15 jours avant, jour de début et de fin de ttt, 15 jours après

-résultats:

<table>
<thead>
<tr>
<th>Patients</th>
<th>Time 1 (mm ± SD)</th>
<th>Time 4 (mm ± SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7.57 ± 3.5</td>
<td>3.86 ± 1.10</td>
</tr>
<tr>
<td>2</td>
<td>13.52 ± 5.05</td>
<td>6.3 ± 1.75</td>
</tr>
<tr>
<td>3</td>
<td>6.36 ± 2.2</td>
<td>3.54 ± 0.8</td>
</tr>
</tbody>
</table>

Mean rightward error of each patient at line bisection task (mean score of five lines) before and after treatment

3-Applications aux déficits cognitifs

Fig. 2. Clock drawing of a patient at Time 1 (a) and at Time 4 (b).
3-Applications aux déficits cognitifs

Négligence spatiale unilatérale
inhibition contralésionnelle


3-Applications aux déficits cognitifs

Négligence spatiale unilatérale
inhibition contralésionnelle

Theta-burst stimulation of the left hemisphere accelerates recovery of hemispatial neglect
Koch et al, 2012

-20 patients, NSU évaluée par BIT, phase subaigue
-randomisé, double aveugle contre placebo
10 patients cTBS
10 patients sham TBS
-programme de 4 semaines:
20 sessions de 45 mn
5 jours par semaine
+ thérapie conventionnelle (entraînement visuospatial)
-évaluation pré, à 2 s, à 4 s
BIT-C (cutoff 129/146) et -B
fonctionnalité connectivité PPC-M1 hémisphère G (PEM)
3-Applications aux déficits cognitifs

Négligence spatiale unilatérale
inhibition contralésionnelle

Theta-burst stimulation of the left hemisphere accelerates recovery of hemispatial neglect

-résultats: BIT
connectivité

réduction de l’excitabilité des connexions fonctionnelles PF dans l’hémisphère sain (G)

Koch et al, 2012
3-Applications aux déficits cognitifs

Fonctions exécutives

Non-invasive cortical stimulation improves post-stroke attention decline

Kang et al, 2009

-10 patients avec déclin cognitif post AVC (MMSE 25)
-randomisé, contre placebo, double aveugle
-tDCS anodal 20 mn, 2mA en regard DLPFC gauche/ sham tDCS

-test de Go/No-Go
-évaluation à 1h et 3h
-amélioration de la précision des réponses dans groupe traité
Mémoire de travail

Enhancing the Working Memory of Stroke Patients Using tDCS

-10 patients post AVC
-cross-over randomisé, contre placebo, double aveugle
-tDCS anodal 30 mn, 2mA en regard DLPFC / sham tDCS
-tâche de MdT 2 back
-amélioration de la précision des réponses dans groupe traité

Jo et al, 2009
3-Applications aux déficits cognitifs

-NIBS pour la négligence prometteur++
-plus larges essais nécessaires

-probablement association nécessaire à des paradigmes de stimulation spécifique pour induire des effets cliniquement pertinents
Predicting behavioural response to TDCS in chronic motor stroke☆

Jacinta O'Shea a,*,1, Marie-Hélène Boudrias a,1, Charlotte Jane Stagg a, Velicia Bachtiar a, Udo Kischka b, Jakob Udby Blicher a,2, Heidi Johansen-Berg a

Experiment 1: Comparative effect of Anodal, Cathodal and Bilateral TDCS on motor-evoked potentials in the healthy brain
Predicting behavioural response to TDCS in chronic motor stroke

Jacinta O'Shea a,⁎, 1, Marie-Hélène Boudrias a, 1, Charlotte Jane Stagg a, Velicia Bachtiar a, Udo Kischka b, Jakob Udby Blicher a, 2, Heidi Johansen-Berg a

Neurolmage, 2014

Experiment 2: Relative effect of Bilateral versus Anodal, Cathodal and Sham TDCS on simple RT with the paretic hand in chronic stroke

dictors of patients' behavioural response to TDCS. There were three main findings: 1) unlike Anodal and Cathodal TDCS, Bilateral M1–M1 TDCS (1 mA, 20 min) had no significant effect on MEPs in the healthy brain or on reaction time with the paretic hand in chronic stroke patients; 2) GABA levels in ipsilesional M1 predicted patients' behavioural gains from Anodal TDCS; and 3) although patients were in the chronic phase, time since stroke (and its combination with Fugl–Meyer score) was a positive predictor of behavioural gain from Cathodal TDCS. These findings indicate the superiority of Anodal or Cathodal over Bilateral TDCS in...
Perspectives

- Amélioration des apprentissages (plasticité synaptique « LTP-like »)
Perspectives

Handicap cognitif: 
Projet PRIStiM1
(PhRC National 2012)

Handicap moteur: 
Projet ReSTIM
(2 inclusions)

Rééducation + 
Rééducation seule

héminégligence

hémiplégie

KINESITHERAPIE INDIVIDUALISEE
Battery powered thought: Enhancement of attention, learning, and memory in healthy adults using transcranial direct current stimulation

Brian A. Coffman\textsuperscript{a,b,c,d}, Vincent P. Clark\textsuperscript{a,b,c,d,*}, Raja Parasuraman\textsuperscript{e}  
NeuroImage, 2014

- tDCS for enhancement of learning and memory
  - Implicit memory: procedural/motor learning
  - Implicit memory: probability learning
  - Explicit learning

- tDCS for enhancement of working memory, attention, and perception
  - Working memory
  - Attention
  - Visual perception
  - Multisensory perception
Higher current densities are seen for both the anode and the cathode at the edge nearest to the opposing electrode, and greater shunting though the scalp is thought to occur for smaller electrodes, though this can be overcome with increased current density (Miranda et al., 2009; Wagner et al., 2007). Furthermore, current density differences at the edge vs. the center of an electrode may be up to a degree of magnitude larger for small (1.5 cm$^2$) EEG electrodes compared to 35 cm$^2$ wet-sponge electrodes (Faria et al., 2009).

The vast majority of tDCS studies purport to deliver a primary form of stimulation, either anodal or cathodal; however, both the anode and cathode are used. Therefore, both electrodes will produce stimulation of different areas of cortex, either beneath the electrodes, or at positions in-between. An alternative option is the use of several electrodes of one polarity and one electrode of the opposite polarity, in order to focalize and increase the current density of the single electrode while reducing the efficacy of the other electrodes. In a study by Miranda et al. (2009), it was suggested that using a disproportionately large electrode could effectively inactivate the electrode. However, this does not account for the tendency of current to concentrate at the corners of electrodes (Ambrus et al., 2011), or along low-resistance pathways that might be created by variation in the density of hair, scalp, and bone.

One protocol being developed to focalize the effects of tDCS is high-definition transcranial direct current stimulation (HD-tDCS; Borckardt et al., 2012), which incorporates multiple nearby reference electrodes that surround the active electrode in a ring-shaped arrangement. This montage, which was derived from computational modeling of current distribution, results in relatively localized current distributions, compared to standard tDCS protocols. Another option is the use of distant, extracephalic electrode placements such as on the collar bone (Elbert et al., 1981), arm (Clark et al., 2012; Coffman et al., 2012a,b; Cogiamanian et al., 2007; Falcone et al., 2012; Priori, 2003), or leg (Lippold and Redfearn, 1964; Meyer-Schwickerath and Magun, 1951).

An extracephalic electrode allows one to ensure that there are no focal effects of the reference electrode location on brain activity directly. It should be noted, however, that the use of a large reference pole electrode has been shown to be less effective than a standard, similarly-sized reference electrode for some applications (Nitsche et al., 2007). Also, a distant return electrode may also reduce the effectiveness of stimulation compared to cranial placement of the return electrode, at least for stimulation of motor cortex (Moliadze et al., 2010).

As similar issues to sham/placebo stimulation. This is an important consideration in design of a tDCS study, as placebo effects could influence the results of any psychological experiment (Shapiro, 1964). Additionally, sensation associated with tDCS can be detected by some participants, regardless of previous experience with tDCS. One group found that 30% of participants were able to distinguish tDCS from no-current placebo at only 0.2 mA (Ambrus et al., 2010). Sensation can be reduced using round electrodes (Ambrus et al., 2011), or by using lidocaine gel (McFadden et al., 2011), but few studies use sensation mitigation methods. The most commonly used sham condition is to deliver the same current strength/density of tDCS that is used in the active stimulation conditions while limiting its duration, such that the duration is long enough to induce physical sensation at the skin, but short enough that there are negligible effects on the cortex. It has been

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**Fig. 3.** Four different examples of electrode placements are shown. A) Motor cortex stimulation protocol (e.g., Nitsche et al., 2003b). B) Right inferior frontal cortex (IFC) stimulation protocol (e.g., Clark et al., 2012). C) Dorsolateral prefrontal cortex (DLPFC) stimulation protocol (e.g., Fregni et al., 2005). D) Occipital cortex stimulation protocol (e.g., Antal et al., 2001). A = Anode; C = Cathode.
tDCS-enhanced motor and cognitive function in neurological diseases

Agnes Flöel *

* Neurolmage, 2014

Road-map for research regarding the use of tDCS in the clinical realm

1. Optimization of stimulation protocols for healthy subjects. Here, recent studies by Batsikadze et al. (2013) and Monte-Silva et al. (2010a, in press) have yielded first important information on stimulation intensity, duration, and repetition intervals. Further information is now needed on the optimal number of stimulation sessions.
2. Establish transfer of stimulation protocol to patient populations using neurophysiological measures
3. Establish transfer of stimulation protocol to patient populations using behavioral measures in pilot trials
4. Establish clinical relevance of specific tDCS protocols in RCTs in patients, using appropriate outcome measures not only covering the specific “function” under study, but also including measures of activities and participation
Plasticité et programmes de rééducation: TMS et tDCS