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Safety of transcranial direct current stimulation in healthy participants

Transcranial direct current stimulation (tDCS) has been used in many research studies worldwide. This technique allows the modulation of neural activity in a non-invasive way. Side effects tend to be rare, mild and disappear after the experiment. Some publications have reported adverse effects including burns and mental health issues in depressed patients [1]. Only one major neurological complication has been reported in the scientific literature [2].

I was in my early thirties, when in 2012, I took part in a tDCS experiment, as a healthy volunteer. After placing tDCS pads on my head and my left shoulder, the experimenter calibrated the

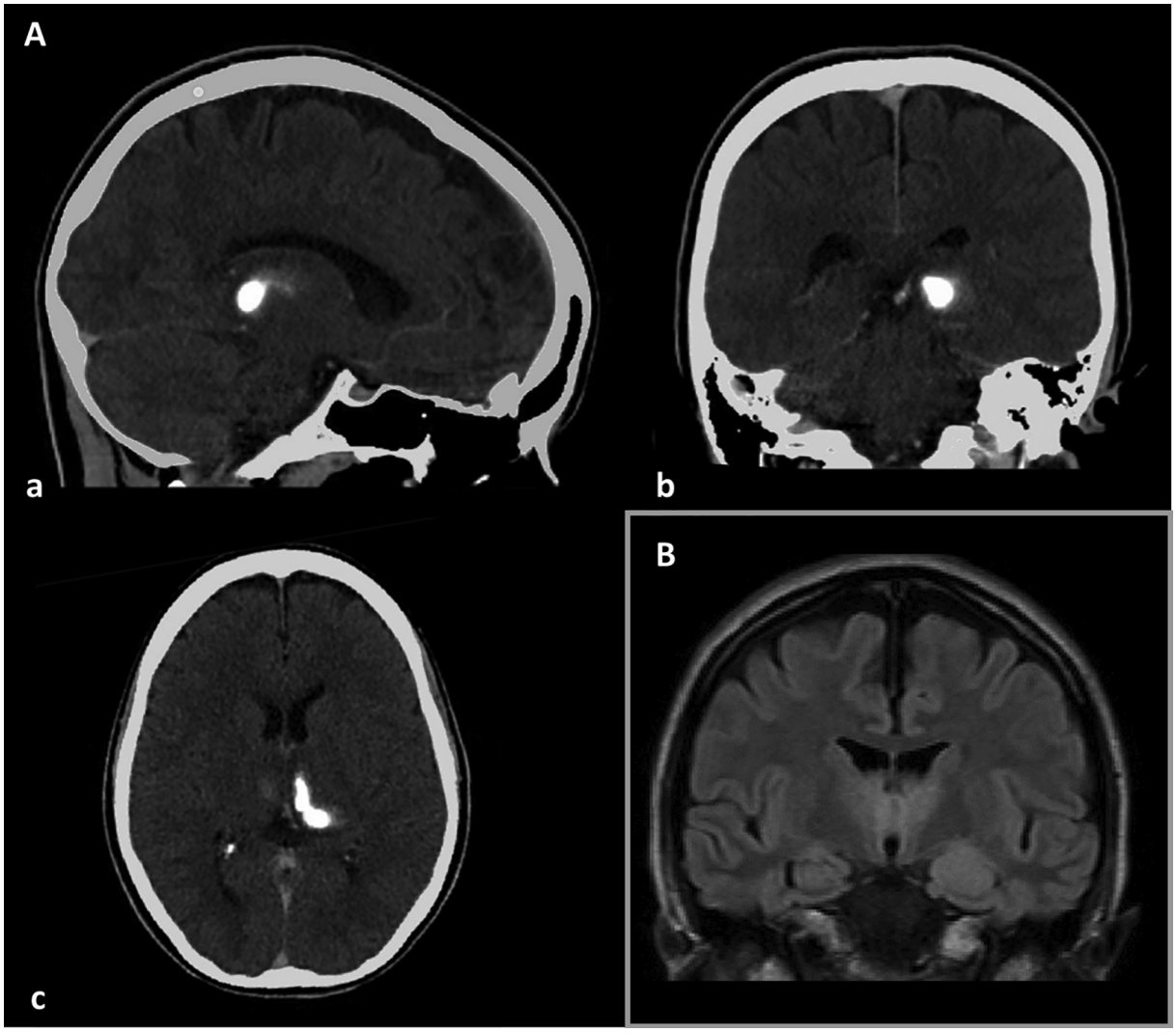

Fig. 1. A. CT-scan showing brain calcifications on sagittal (a), coronal (b) and axial (c) views. B. MRI showing both amygdalae on a coronal view, with the left bigger than the right one.

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stimulation just below the lowest current that induced a tingling sensation. I performed an Erickson flanker task, being blinded to the stimulation status. The experimental design consisted of 2 similar stimulation programs each of 8 sessions of 1.5 minutes stimulation at 750 micro-amps, at 6 Hz and 70 Hz.

Three weeks after receiving tDCS, I started to experience lucid dreams. I had the sense that I was dreaming while being awake. I began to experience strong déjà vu sensations when listening to someone speaking. After these events, I felt a little confused. Also, I began to suffer with panic attacks and a general anxiety syndrome.

I was referred to the local epilepsy clinic. An electroencephalogram recording demonstrated an epileptogenic focus in my left temporal lobe. Brain imaging revealed a left calcified thalamus and an abnormality in the left amygdala (Fig. 1). This anomaly was first diagnosed as a tumour, most likely an oligodendroglioma. Ironically, gliomas were the topic of my Ph.D. thesis [3].

Over the following years, Magnetic Resonance Imaging (MRI) showed no changes, demonstrating that the origin of the epilepsy was not tumoral. It seems, rather, that the asymptomatic changes detected on imaging rendered my brain susceptible to seizures. I feared the micro-current introduced by the tDCS may have aggravated a pre-existent subclinical cortico-subcortical network and triggered focal epilepsy despite reported safety.

As a healthy 33-year old woman, with no family history of epilepsy and taking no regular medication, I was a seemingly ideal healthy volunteer. I am now prescribed daily doses of Clobazam (20 mg), Eslicarbazepine (600 mg) and Venlafaxine (150 mg), having trialled other antiseizure medications and other antidepressants previously. Eight years after the experiment, I still experience recurrent seizures, a debilitating fatigue, and a driving restriction. The impact of epilepsy remains considerable.

As a neuroscientist and now as an epilepsy patient, I do think it is essential that researchers consider the safety consequences of healthy volunteers. Asymptomatic volunteers should perhaps be screened by detailed questionnaires, clinical examinations and/or MRI. Any structural abnormality incidentally found, may render these volunteers ineligible for tDCS studies. Systematic brain imaging might be onerous for the study sponsor, but it has to be weighed against any potential cost of indemnity claims, and the health-system burden induced by possible side-effects of tDCS. On top of this, volunteer safety is an overarching priority.

SB initiated and wrote the first draft of the manuscript. AS is SB's treating physician.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Sandra Boccard-Binet [a,*]
Arjune Sen [b]
[a] *Nuffield Department of Surgical Sciences, John Radcliffe Hospital, University of Oxford, UK*
[b] *Oxford Epilepsy Research Group, National Institute for Health Research Oxford Biomedical Research Centre, Nuffield Department of Clinical Neurosciences, John Radcliffe Hospital, University of Oxford, UK*
* Corresponding author at: University of Oxford, Nuffield Department of Surgical Sciences, Level 6, West Wing, John Radcliffe Hospital, Headley way, Headington, Oxford, Oxfordshire OX3 9DU, UK.
E-mail address: sandra.boccard@nds.ox.ac.uk (S. Boccard-Binet)

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