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Letter to the Editor

A Double-blind, Placebo-controlled Study of the Effects of Daily tDCS Sessions Targeting the Dorsolateral Prefrontal Cortex on Tinnitus Handicap Inventory and Visual Analog Scale Scores

Dear Editor,

Tinnitus is a common condition that affects approximately 20.7% of the general population, according to a recent study [1]. Although different causes may be at play, a likely pathophysiological mechanism might be, for example, maladaptive reorganization of the auditory cortex in response to cochlear damage or degeneration and auditory loss restricted to specific sound frequencies. The persistence of continuous neural activity in the corresponding tonotopic cortical representation areas might, then, cause phantom perception of sound in the affected frequencies, leading to tinnitus. In fact, it has been shown that tDCS targeting the auditory cortex is capable of transiently modulating tinnitus intensity [2].

However, the affective and emotional aspects of tinnitus perception may be very important to the degree of patient discomfort, irrespective of tinnitus intensity. Approximately one-third of patients report moderate to severe tinnitus-related annoyance [1]. Since tDCS targeting the dorsolateral prefrontal cortex (DLPFC) has already been shown to modulate depression and other neuropsychiatric symptoms [3–5], a few studies have explored possible effects of tDCS on subjective tinnitus-related discomfort and annoyance [6]. Vanneste et al. [7] reported that one session of bilateral DLPFC tDCS had an acute tinnitus-suppressing effect, but only with a right anode-left cathode montage. Frank et al. [8] found that 6 sessions of tDCS targeting the DLPFC decreased perceived discomfort due to tinnitus, but did not significantly change Tinnitus Handicap Inventory (THI) scores. In that study, patients received tDCS twice a week. Faber et al. [9] also performed a study with two tDCS sessions per week. All other studies published to date have measured tinnitus discomfort and intensity before and after single sessions of tDCS [6]. It is conceivable, therefore, that a daily stimulation protocol, as has been proposed for the treatment of depression and chronic pain [10], could result in a cumulative and significant effect of tDCS sessions targeting the DLPFC on THI and VAS scores.

Here, we report a study of two groups of tinnitus patients carried out with a double-blind, placebo-controlled design, to test the hypothesis that 5 consecutive daily sessions of tDCS targeting the DLPFC could have a significant effect upon THI and VAS scores.

Eighteen patients with chronic tinnitus were enrolled in this study after giving written, informed consent. Nine men and 9

women, ages 45–70 (mean 54.72) participated in the study. Mean tinnitus duration was 12.86 years (range: 1–30 years).

All patients had sensorineural hearing loss, which was bilateral in nine. Patients with a history of seizures, suspected organic brain damage, depression, as well as patients with cardiac pacemakers, pregnant women and those taking medications acting on the central nervous system were excluded.

All tDCS sessions were performed at the Neuromodulation Laboratory, Psychiatry Unit, University of Brasília Hospital, Brasília, Brazil. The experimental protocol was approved by the local Ethics Committee.

Patients were randomly assigned to either a real tDCS or a sham procedure group. All patients underwent 5 daily consecutive tDCS sessions. Visual analog scale (VAS) and Tinnitus Handicap Inventory (THI) scores were recorded before and after treatment.

tDCS was delivered by an Endophasys D[®] stimulator (KLD Instruments, São Paulo, Brazil) through electrodes embedded in sponges (area: 35 cm²) soaked with NaCl 0.9%. The cathode was placed over the left dorsolateral prefrontal cortex (DLPFC) with the center over F3 (10–20 system), and the anode over the right DLPFC (F4). Stimulation was performed at 2.0 mA over 20 min (10 s ramp-in and ramp-out each). During the sham procedure, there was also a ramp-in period of 10 s, after which the current was turned off for the remainder of the session, in order to cause the same ramp-in sensations experienced by the real tDCS group.

The procedure was well tolerated by all subjects, with no untoward effects.

Statistical analysis was performed with the Kruskal–Walis Test, in order to verify if there were significant interactions between VAS and THI scores, real tDCS and sham tDCS. The Wilcoxon signed-rank test was used to compare the real and sham treatment groups, as well as VAS and THI scores before and after treatment. There were no significant effects of tDCS upon VAS or THI scores at the 95% confidence level.

Figure 1 shows the grouped mean VAS and THI scores for the real tDCS and sham stimulation groups before and after treatment.

In conclusion, five consecutive bifrontal tDCS sessions, with the right anode-left cathode montage previously reported as having an acute beneficial effect after just one tDCS session [7] did not result in significant improvement in either VAS or THI scores. This result is in agreement with a previous study of repeated sessions of prefrontal tDCS, which, however, employed only a twice-a-week tDCS protocol [8]. A recent review [6] also pointed out that previous studies have demonstrated a lack of long-term effects of tDCS upon emotions associated with tinnitus, which is in keeping with our THI results. As to the VAS, which measured perceived tinnitus intensity, we were unable to demonstrate a significant beneficial effect, as has been shown by Vanneste et al. [7] with an open label, single-session protocol. This might be due to the fact that we did not record intensity VAS scores after just one session; it might be the case that such effect is only demonstrable after a first, single tDCS session and then some kind of habituation might take place. Another possible explanation is that they studied a very large number of patients, albeit

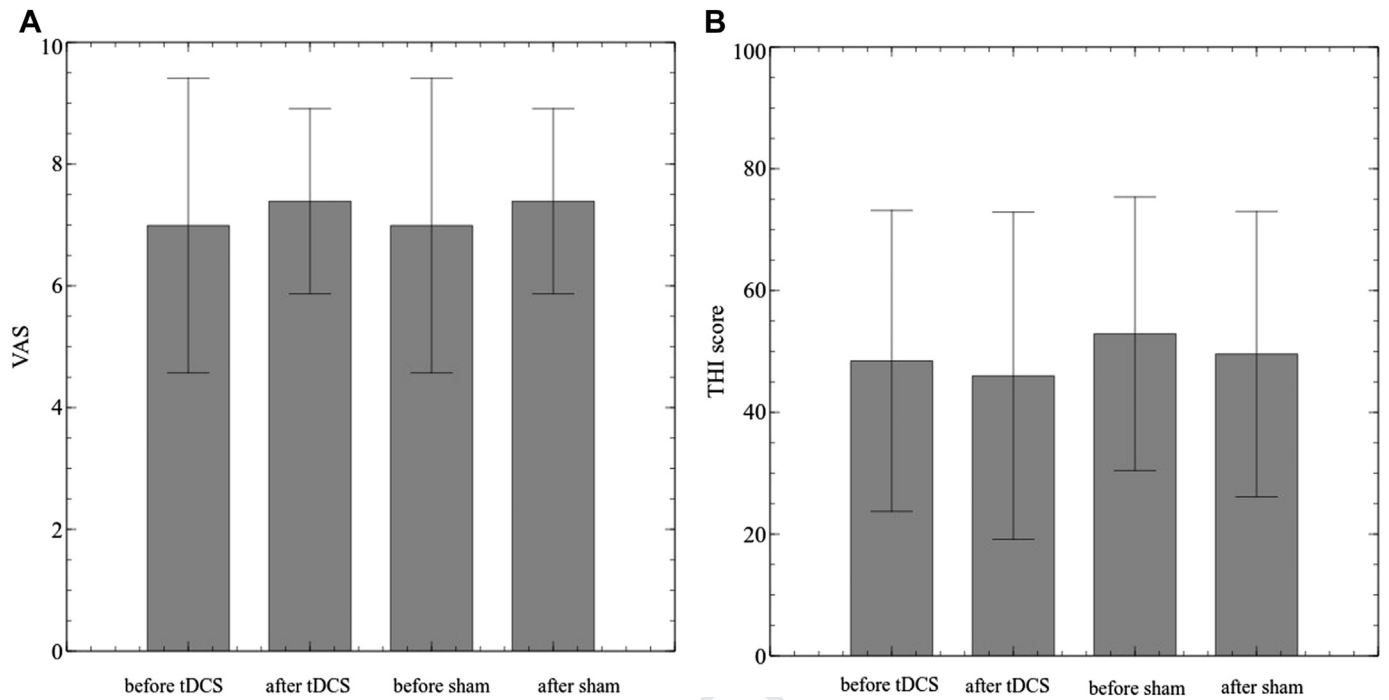


Figure 1. Grouped mean VAS (A) and THI (B) scores before and after real and sham tDCS. Error bars are standard deviations of the mean. The Kruskal–Walis test did not show significant differences between the groups at the 95% confidence level.

with an open-label protocol, thus achieving enough statistical power to allow for the demonstration of the effect in 29.9% of their patients [7]. However, since their study was not placebo-controlled, a placebo effect cannot be ruled out.

This is, to our knowledge, the first double-blind, placebo-controlled study to employ daily tDCS sessions targeting prefrontal areas for treatment of chronic tinnitus, although a daily stimulation regimen has already become common practice in studies of other neuropsychiatric disorders, such as chronic pain and depression.

Acknowledgments

We thank Maria Célia Vitor de Souza Brangioni, Bruno Andrade Jess, and Vanessa Ferreira Costa for their invaluable collaboration in recruiting, testing the participants and recording the data for this study.

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Received 22 June 2015

Available online xxx

<http://dx.doi.org/10.1016/j.brs.2015.06.019>

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