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Letter to the editor

Effect of a single early EEG neurofeedback training on remediation of spatial neglect in the acute phase

Dear Editor,

Spatial neglect is one of the most frequent and disabling neuropsychological syndromes following right-hemisphere damage. Patients with neglect fail to report, orient to, or verbally describe stimuli in their contralesional left hemispace [1]. This disorder is among the major factors underlying poor functional outcome. Various rehabilitation techniques exist but still fail to significantly improve patients' visuospatial function in a lasting manner in real life [2]. Here, we investigated the effects of a brief intervention with electroencephalography (EEG)-neurofeedback (EEG-NFB) in neglect patients shortly after acute stroke. EEG-NFB provides patients with a real-time measure of their brain activity that reflects visuospatial attention (alpha power recorded from posterior EEG electrodes) and allows for training voluntary control of the attentional state.

We tested 4 patients (mean [SD] age 54.3 [16.8], 1 women; all right-handed) with a first right-hemispheric stroke (MRI-confirmed; mean post-stroke delay 10.5 days). Spatial neglect was assessed with the following 3 tests: line bisection, scene copying, and bell cancellation before, just after, and 1 week after the EEG-NFB training session, without any explicit feedback on behavioral performance. EEG-NFB was used to record, process, and translate real-time indices of brain activity by use of a dedicated computer. The neural parameter used for NFB was the power of alpha oscillations (8–12 Hz range) over the right posterior parietal cortex (rPPC), corresponding to the P4 electrode in the 10–20 international EEG positioning system. The brain–computer interface computed the alpha power in real-time to provide moment-to-moment feedback to the participant based on its mean amplitude (http://www.hbimed.com/). Patients were asked to attempt to lower their alpha amplitude over the course of a single 30-min-long NFB session (divided into 10 blocks of 3 min each). The feedback signal displayed on the computer screen directly reflected the magnitude of changes in alpha power relative to baseline, by use of a game-like procedure (e.g., a spaceship at the screen center, moving forward only when the alpha was below a given reward threshold, which was set at the mean amplitude of spontaneous alpha power before training). NFB training with a similar software and feedback display has been successfully used

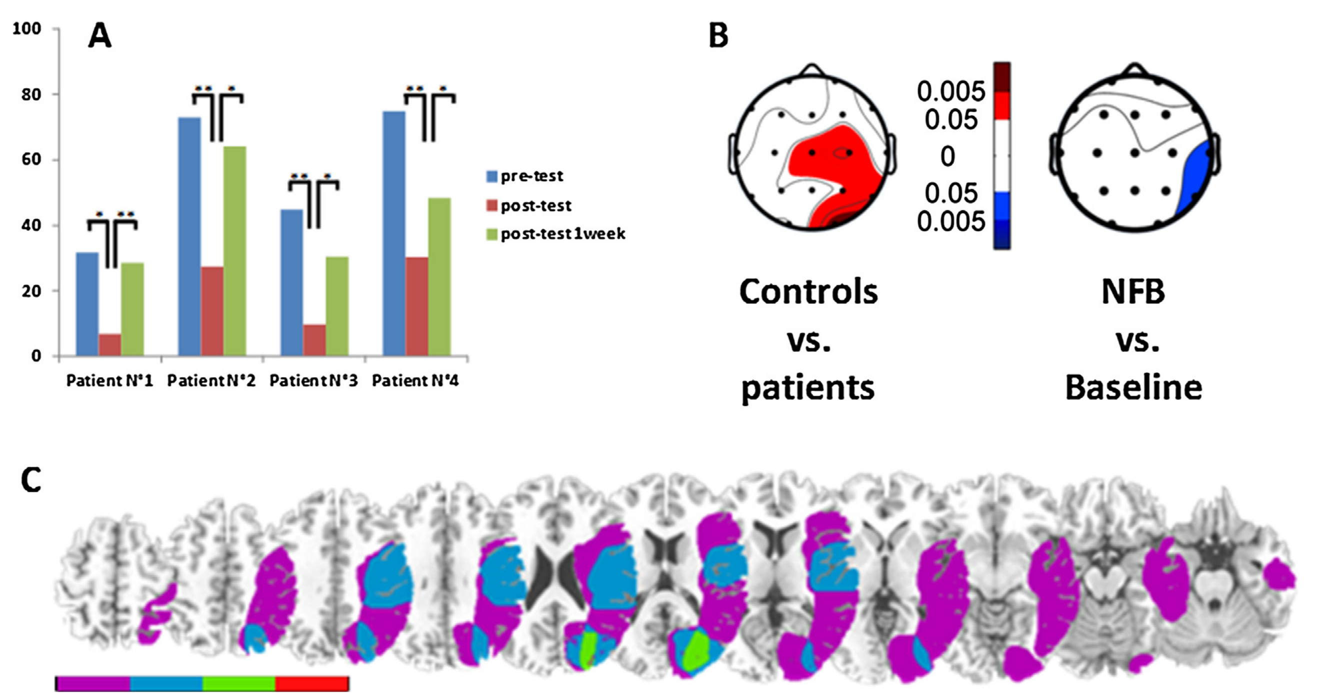

Fig. 1. A. Spatial neglect score for the 4 patients before and after electroencephalography-neurofeedback (EEG-NBF) training. * $P < 0.05$; ** $P < 0.01$. B. Mean alpha power between controls versus patients and NBF versus baseline. C. Lesion overlap in the 4 patients. The colour range indicates the number of patients presenting a lesion in each pixel (1 = purple; 4 = red).

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in other domains [3]. All participants gave their written informed consent to participate. This observational study was performed in accordance with the Declaration of Helsinki.

Before NFB, patients with acute neglect presented a distinct right-lateralized EEG abnormality (i.e., excess amplitude within the alpha-band) (Fig. 1), which was consistent with previous findings in stroke patients [4]. However, during NFB, all 4 patients could successfully reduce posterior alpha power. Behaviorally, after NFB, the 3 clinical visuospatial tasks showed decreased error rates (mean neglect score 18%) as compared with before NFB (56%; $P = 0.01$) and 1 week after (42%; $P = 0.02$). The difference in error rates between before NFB and 1 week after was not significant ($P = 0.18$).

These preliminary data demonstrate for the first time that neglect deficits can be improved after a single session of NFB in the early phase post-stroke. However, these promising results are limited by a small sample of only 4 patients. NFB training aiming at reducing alpha-rhythm (8–12 Hz) over the right parietal lobe may act by promoting the functional recruitment of this brain region and trigger plastic mechanisms in brain networks controlling spatial attention [5]. This activity might improve neglect deficits by inducing a more balanced inter-hemispheric activation of the parietal cortex, potentially restoring sensory responses in the visual cortex of the damaged hemisphere. These results agree with other plasticity-based rehabilitation techniques such as prism-adaptation [6]. Moreover, a similar EEG-based methodology could easily be explored and applied in a host of other neurological deficits (e.g., hemianopia, hemiparesis) to promote early recovery mechanisms. In comparison with other emerging therapies such as transcranial magnetic stimulation (TMS) and transcranial direct current stimulation, potential advantages of EEG-based NFB approaches are their low cost, safety (only the natural operation of the brain is implicated, with no risk of seizures documented to date), and the lack of pain or discomfort (rTMS is occasionally reported as painful depending on the stimulation site).

Taken together, the feasibility and impact of the NFB approach we present should encourage more thorough investigation of the possible applications of this innovative technology for human stroke and neuro-rehabilitation in general.

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Disclosure of interest

The authors declare that they have no competing interest.

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