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Enhanced modulation of working memory activity through fMRI neurofeedback

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Introduction: BCI paradigms often rely on the ability to modulate brain activity between active and resting states. Improving the ability to shift between these states will provide better BCI control. We tested the hypothesis that it is possible to improve the shift between rest and performance in working memory (WM) through neurofeedback. Neurofeedback was given on the left dorsolateral prefrontal cortex (DLPFC), an important brain region for WM that has been shown to be a reliable brain region for BCI control [1, 2, 3].

Material, Methods and Results: 24 healthy volunteers participated in a 7 tesla real-time fMRI experiment (2D EPI, TR/TE: 2.0 s/25 ms; 2.2 mm isotropic). Participants performed a neurofeedback task, where they were required to move an animated figure up and down a ladder to pick apples. The position of the figure was controlled by performing a 'count back' paradigm that activated the left DLPFC. The goal of the task was to pick as many apples as possible in five periods of 2.5 minutes. An experimental group (N=13) was allowed to practice the neurofeedback task during five practice periods of 2.5 minutes. A control group (N=11) participated in an identical experiment, except that they received sham feedback during the five practice periods. In both groups the performance on the neurofeedback task (with actual feedback) was measured before and after the five practice periods, as well as the effect of neurofeedback on the overshoot, undershoot and slopes of the BOLD signal in a number of subjects.

The improvement in task performance after practice was significantly higher in the experimental group than in the control group (p = .040; see figure 1). The improvement in task performance in the experimental group could predominantly be attributed to the improved ability to decrease the BOLD after practice (p = .016). The control group did not show this improvement.

Discussion: Our results indicate the possibility to improve control over DLPFC activity using neurofeedback after a short amount of training. Analysis of the BOLD signal indicates that in particular the ability to switch form high to low activity in the DLPFC can benefit from neurofeedback. This enhanced ability can improve control of a BCI that uses activation and deactivation of DLPFC for triggers.

Significance: Our research shows that it is possible to improve the ability to modulate brain activity in the left DLPFC practice through neurofeedback, mainly due to improved ability to reduce activation. This improvement can increase performance of a WM-BCI which uses a resting state - active state paradigm for BCI control.

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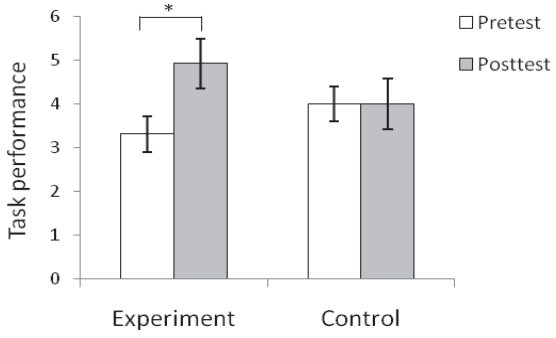

Figure 1. Behavioral results on the neurofeedback task before and after practice.