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Effect of visuomotor coordination and relaxation repeated interventions for Sensorimotor Brain Computer Interfaces

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Introduction: Sensorimotor-rhythms based brain computer interfaces (SMR BCIs) allow a user to send commands to a device by the modulation of brain activity in the sensorimotor cortex. After decades of investigation on the topic, we still find that 10 to 50% of users do not achieve control of the device [1]. The current study investigates within a pre-post design the effect of training of previously identified predictors on SMR-BCI performance, namely, visuomotor coordination ability [2,3] and relaxation [4].

Methods: N=39, BCI-naïve participants were randomly assigned to 3 intervention groups (n=13 per group): "Relaxation group": listening to a Progressive Muscle Relaxation audio file. "Visuomotor group": the goal was to steer a point through narrow paths on the screen with two knob controllers. "Reading group": participants were given a book to read (control). Intervention lasted 23 minutes on each of 4 consecutive days (session 1 to 4). EEG was recorded from 64 active electrodes. SMR BCI sessions were conducted on day 1 (prior to training) and on day 5 after training using the Berlin BCI Matlab Toolbox with co-adaptive calibration [5]. Participants performed right and left hand motor imageries to move a cursor on a horizontal axis during 320 trials (1s fixation cross, 1s directional cue, 4s feedback, 4s ITI). Performance was the ability to move the cursor in the cued direction. Questionnaires were answered prior and during the BCI session and assessed "self-regulation" (SR trait) and "state-mindfulness scale" (SMS state, mindfulness of sensations). Visual analogue scales (VAS 0 to 10) for relaxation were filled out after interventions.

Results: A significant effect of time on BCI performance was found ($p<.05$, $M_{pre}=65.3\%$, $M_{post}=68.3\%$, see figure 1), but no effect of group or interaction. There was an improvement in the visuomotor precision (reduction in the critical mean duration) between day 1 and day 4 ($M_{d5\text{-}d1}=-1.17$, $p<.01$). Critical mean error duration during the last visuomotor training session was negatively correlated with BCI performance post (rho=-.62, $p<.05$). Participants in the relaxation group had higher relaxation levels (M=8.5) after intervention compared to visuomotor (M=6.8, $p<.01$) and reading (M=7.4, $p<.05$) groups. State mindfulness (SMS_{post}) was positively correlated with post BCI performance (rho=.47, $p<.01$) and self-regulation was negatively correlated with post BCI performance (rho=-.32, $p<.05$).

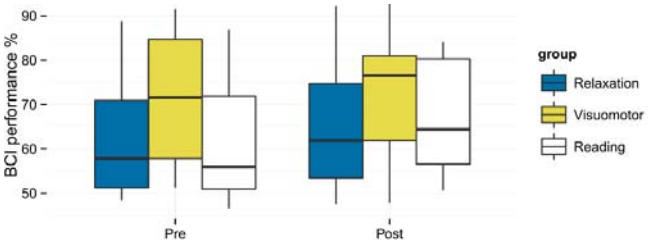

Figure 1. *BCI performance % (n=13 per group)*

Discussion: Confirming results from previous studies [2,3] for the 3rd time, the visuomotor coordination ability was positively associated with BCI performance. However, we found no effect of training, neither for the visuomotor coordination abilities nor for relaxation, albeit both predictors improved with training. We may speculate that the improvements were not large enough to affect BCI performance. In line with current research [6,7], mindfulness was positively correlated with BCI performance.

Significance: One week of daily repeated interventions could not improve BCI performance. Mindfulness was confirmed and self-regulation appeared new as correlates of SMR-BCI accuracy.

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